# Curriculum for
# Civil Engineering
## Bachelor of Engineering Program
## 2023

Pakistan Engineering Council
&
Higher Education Commission
Islamabad

# CURRICULUM

# OF

# CIVIL ENGINEERING

## Bachelor of Engineering Program

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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 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 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 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 of 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 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 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 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 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 Undergraduate Education Policy (UEP) to be implemented from Fall-2023 for all HEIs and Councils. In this regard, he appreciated PEC EAB working and notification of engineering education guidelines/ framework document, evolved based on the synthesis and mapping 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 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<br>Convener (ECRDC-Main)/ Member PEC Governing Body/<br>Rector NUST, Islamabad | Convener |
| 2. | Engr. Prof. Dr. Altaf Mukati<br>Vice President (Academics)<br>SZABIST University, Karachi | Dy. Convener |
| 3. | Engr. Prof. Dr. Bhawani Shankar Chowdhry<br>Member, PEC Governing Body /<br>Prof. Emeritus /Advisor MUET | Member |
| 4. | Engr. Prof. Dr. Shahid Khattak<br>Convener, Elect Engg & Allied Disciplines | Member |
| 5. | Engr. Prof. Dr. Ehsan Ullah Khan Kakar<br>Convener, Civil Engg & Allied Disciplines | Member |

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

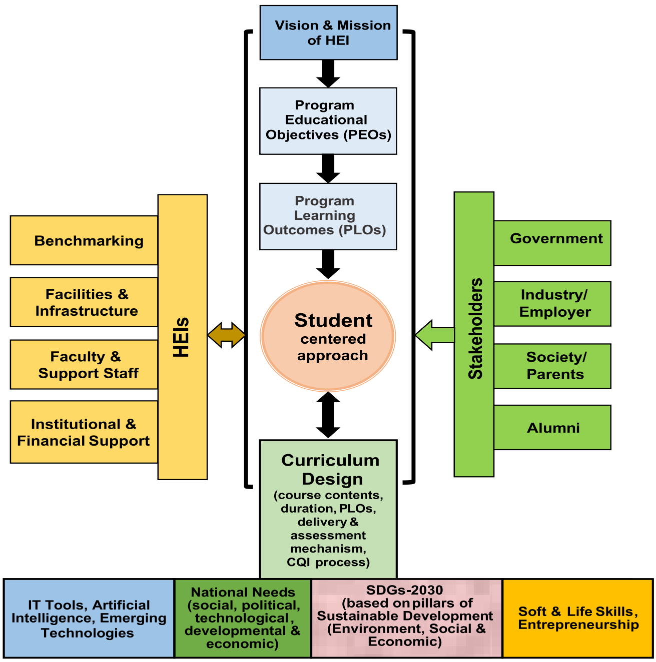
## 2. ECRDC Agenda

- 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

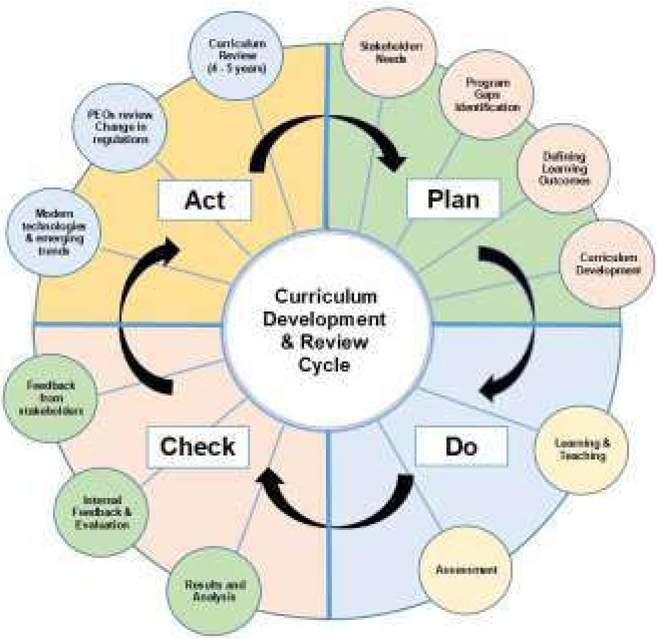
Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student's centered system which concerns what the students will know and be able to do as learning outcomes. The curriculum development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

**Do.** The Do plan stage is implemented where 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 Civil & Allied Engineering Disciplines

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Civil and Allied Engineering Disciplines took up the task to review and update the curriculum for Bachelor of Civil Engineering degree program. The subject Committee had seven meetings besides multiple sessions of Sub-Groups and the concluding meeting of ECRDC (Civil Engineering) was conducted on 11-1-2024 at PEC Head Office Islamabad. The Committee consisted of following members:

| | | |
|---|---|---|
| 1. | Engr. Prof. Dr. Ehsan Ullah Khan Kakar<br>Vice Chancellor, University of Loralai, Loralai | Convener |
| 2. | Engr. Prof. Dr. Aneel Kumar<br>Pro-Vice Chancellor, MUET Jamshoro | Member |
| 3. | Engr. Syed Nafasat Raza<br>SE, Highway Department Rawalpindi | Member |
| 4. | Engr. Azhar-ul-Islam Zafar<br>CEO, AMS Engineers & Contractors | Member |
| 5. | Engr. Ata ur Rehman<br>DG, Small Dams Irrigation Departments KP | Member |
| 6. | Engr. Sohail Bashir<br>COO, SAITA (Pvt.) Ltd. | Member |
| 7. | Engr. Khalid Sultan<br>Chief Engineer, Communication & Work Highways, AJ&K | Member |
| 8. | Engr. Rashid Ahmed<br>Chief Engineer PWD, Giligit Baltistan | Member |
| 9. | Engr. Prof. Dr. Attaullah Shah<br>Vice Chancellor, Karakoram International University,<br>Giligit Baltistan | Co-opted Member |

10. Engr. Dr. Waseem Khaliq — Co-opted Member
    Professor, NUST, Islamabad

11. Engr. Dr. Abdul Jabbar Sangi — Co-opted Member
    Professor, NED-UET, Karachi

12. Engr. Dr. Sher Jamal Khan — Co-opted Member
    Professor, NUST, Islamabad

13. Engr. Dr. Zubair Abu Bakar — Co-opted Member
    Professor, UET, Lahore

14. Engr. Dr. Majid Ali — Co-opted Member
    Professor, CUST, Islamabad

15. Engr. Dr. Khalid Farooq — Co-opted Member
    Professor, UET, Lahore

16. Engr. Dr. Imran Hafeez — Co-opted Member
    Professor, UET, Taxila

17. Engr. Dr. Khan Zaib Jadoon — Co-opted Member
    Professor, IIUI, Islamabad

18. Engr. Dr. Naveed Ahmed — Co-opted Member
    Professor, UET, Taxila

19. Engr. Dr. Abdul Sami Qureshi — Co-opted Member
    Professor, MUET, Jamshoro

20. Engr. Dr. Habib-ur- Rehman — Co-opted Member
    Professor, UET, Lahore

21. Engr. Prof. Dr. Abdul Sattar Shakir — Co-opted Member
    VC, Punjab-Tianjin University of Technology, Lahore

22. Engr. Abdul Qadeer — Co-opted Member
    Ex-VP, NESPAK, Islamabad

23. Mr. Hidayatullah Kasi — Co-opted Member
    HEC Representative

24. Engr. Niaz Ahmed — Secretary ECRDC
    Sr. Additional Registrar / HoD-EAD

25. Engr. Osaf Mahmood Malik — Additional Registrar, EAD
    Section Head (Curriculum & Development)

26. Engr. Syed Haider Abbas Bokhari — Assistant Registrar, EAD

27. Mr. Muhammad Irfan — Office Superintendent-EAD

The working on curriculum development of Civil Engineering was initiated in 2022 by 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 Civil and Allied Engineering Disciplines.

## Sub-Group Civil Engineering (Engineering Domain)

1. Engr. Dr. Aneel Kumar — Lead Sub-Group
   Pro- Vice Chancellor & Professor, MUET Jamshoro

2. Engr. Dr. Abdul Jabbar Sangi — Co-Lead
   Professor, NED-UET, Karachi

3. Engr. Sohail Bashir — Member
   COO, SAITA (Pvt.) Ltd.

4. Engr. Dr. Imran Hafeez — Member
   Professor, UET Taxila

5. Engr. Dr. Habib-ur-Rehman — Member
   Professor, UET Lahore

| | | |
|---|---|---|
| 6. | Engr. Dr. Waseem Khaliq<br>Professor, NUST, Islamabad | Member |
| 7. | Engr. Abdul Qadeer<br>Ex-VP, NESPAK Islamabad | Member |
| 8. | Engr. Dr. Majid Ali<br>Professor, CUST, Islamabad | Member |
| 9. | Engr. Dr. Khan Zaib Jadoon<br>Professor, IIUI Islamabad | Member |
| 10. | Engr. Dr. Khalid Farooq<br>Professor, UET, Lahore | Member |
| 11. | Engr. Dr. Sher Jamal Khan<br>Professor, NUST, Islamabad | Member |
| 12. | Engr. Dr. Munawar Iqbal<br>PPIB, Islamabad | Member |
| 13. | Engr. Dr. Riaz Bhanbro<br>Professor, QUEST, Nawabshah | Expert |
| 14. | Engr. Dr. Naik Muhamad<br>Associate Professor, BUITEMS, Quetta | Expert |
| 15. | Engr. Dr. Khan Shahzada<br>Professor, UET, Peshawar | Expert |
| 16. | Engr. Dr. Rao Arsalan Khushnood<br>Professor, Tunneling Institute of Pakistan<br>CEO, Structax, Islamabad | Expert |

## Sub-Group Civil Engineering (Non-Engineering Domain)

| | | |
|---|---|---|
| 1. | Engr. Dr. Abdul Sami Qureshi<br>Professor, MUET Jamshoro | Lead Sub-Group |
| 2. | Engr. Azahr-ul-Islam Zafar<br>Member, PEC Governing Body/<br>CEO, AMS Engineers & Contractors | Co-Lead |
| 3. | Engr. Syed Nafasat Raza<br>Member, PEC Governing Body/<br>SE, Highway Department Rawalpindi | Member |
| 4. | Engr. Abdul Qadeer<br>Ex-VP, NESPAK Islamabad | Member |
| 5. | Engr. Prof. Dr. Attaullah Shah<br>VC KIU, Gilgit | Member |
| 6. | Engr. Dr Abdul Raziq<br>Professor, BUITEMS, Quetta | Expert |
| 7. | Engr. Dr. Farrukh Arif<br>Professor, NED, Karachi | Expert |
| 8. | Engr. Dr. Muhammad Ali Shah<br>CES, PAEC | Expert |
| 9. | Dr. Faisal Yousafzai<br>MCE, NUST, Risalpur | Expert (Mathematics) |

The ECRDC Civil and Allied Engineering Disciplines appreciated the extra-ordinary efforts and contribution of Engr. Prof. Dr. Ehsan Ullah Kakar (Convener), Engr. Prof. Dr. Majid Ali (Member), Engr. Dr. Rao Arsalan (Expert) & Engr. Osaf Mahmood Malik (Section Head Curriculum & Development) for compilation of course contents and proof reading of this curriculum booklet.

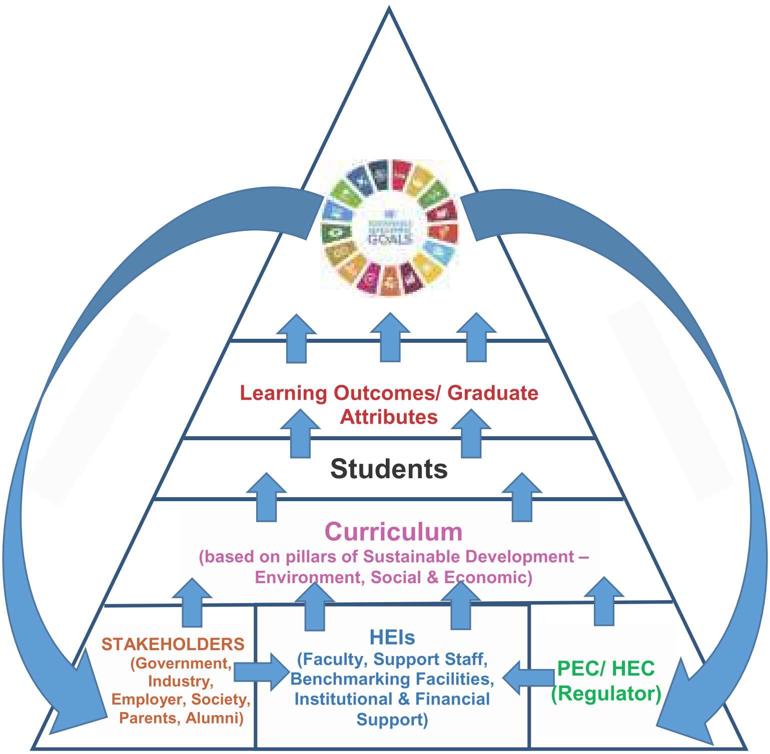
## 6. Agenda of ECRDC for Civil and Allied Engineering Disciplines

- The Subject ECRDC will work under the overall directions and supervision of main ECRDC comprising all Conveners.
- The key driving lines for the development of 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 / HEC policies.
- Review of polices 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. Ehsan Ullah Kakar 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 of professors and experts from academia, industry and R&D institutions has provided a useful input and suggestions covering new developments to be incorporated in the curriculum. He also highlighted the importance of the field of emerging field for achieving sustainable developments while addressing socio-economic issues and challenges envisaged in SDGs-2030 (as provided below) and well mapped with courses;

- 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 upon the above SDGs alongside their mapping strategy with program mission, objectives, learning attributes and the scheme of study.

# 7. Attainment of Graduate Attribute 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 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 the 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)

Therefore, the UN SDGs have been considered in curriculum design (Figure 2). The Bachelors of Engineering Program may be mapped with the UN SDGs keeping in mind its curriculum, other pre-requisites (if any) e.g. survey camp, internship, community service etc., co- and extra- curricular activities as well as theHEI's charter (having emphasis on the particular program). The mapping can be done (through the key phrases in SDGs) on the basis of low, medium and/or high emphasis as well as direct/indirect relevance. The non-exhausted list of considered key phrases of UN SDGs for the purpose of mapping is available in Annexure A (Note: HEI may get it shortened or lengthened as per the need of the respective engineering program). The purpose of emphasizing the SDGs is to (i) join hands with the Provincial/Federal government in playing their effective role from HEI point of view and (ii) to educate/aware the student population about the challenges of the world to be overcome in their professional careers with the help of these UN SDGs. For mapping with curriculum, mapping may be targeted through course description, objectives, learning outcomes, course contents and/or class activities. Similarly, other pre-requites can be mapped. For mapping of co-and extra- curricular activities, the nature of activities may be designed keeping in mind the relevant SDGs. For mapping of HEI's charter (having emphasis on the particular program) with the SDGs, the vision and mission of the HEI may be considered.

## OBE Curriculum towards SDGs-2030 Attainment

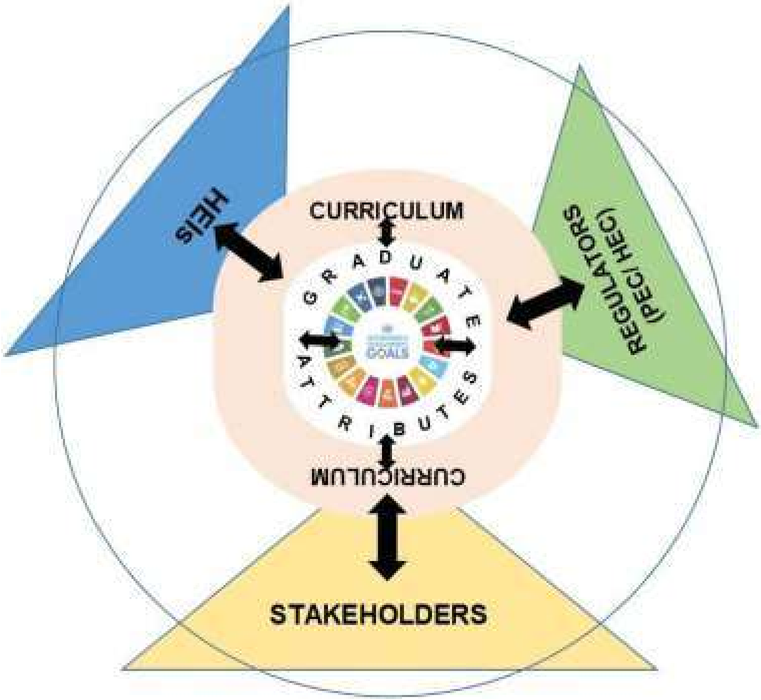



Figure 2: Consideration of UN SDGs in curriculum design

The following template may be adopted for the mapping of the bachelors of engineering program with the United Nation's Sustainable Development Goals (UN SDGs):

| Ser | Description | UN SDGs | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 1 | HEI vision and mission with focus on specific engineering program | | | | | | | | | | | | | | | | | |
| 2 | Bachelor of Engineering Curriculum (Engg. & Non-Engg. Courses) | | | | | | | | | | | | | | | | | |
| 3 | Final Year Design Project (FYDP) | | | | | | | | | | | | | | | | | |
| 4 | Other pre-requisite activities (Internship, Community service, Survey camp, etc) | | | | | | | | | | | | | | | | | |
| 5 | Co- and Extra-Curricular Activities | | | | | | | | | | | | | | | | | |

*Note: The ticks "√" may be placed in cells where mapping is being considered by the HEI.*

As an example, the following non engineering and engineering courses have been mapped with the UN SDGs for the guidance purpose (Annexure B) and included in course outline section:

- Sociology for Engineers
- Reinforced Concrete Design

HEI is expected to design the mapping considering the defined strategy.

## 9. 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**<br>**Engineering Knowledge:**<br>Breadth, depth and type of knowledge, both theoretical and practical | **EC-1**<br>**Comprehend and apply universal knowledge**<br>& **EC-2**<br>**Comprehend and apply local knowledge** | (WK-1, WK-2, WK-3 & WK-4)<br>**WK-1**<br>**Natural sciences** and awareness of relevant **social sciences**<br>**WK-2**<br>**Mathematics & computing**<br>**WK-3**<br>**Engineering fundamentals**<br>**WK-4**<br>**Engineering specialist knowledge** | SDG-9 |
| **PLO-2**<br>**Problem Analysis**: Complexity of analysis | **EC-3**<br>**Problem analysis** | (WK-1, WK-2, WK-3 &WK-4)<br>**WK-1**<br>**Natural sciences** and awareness of relevant **social sciences**<br>**WK-2**<br>**Mathematics & computing**<br>**WK-3**<br>**Engineering fundamentals**<br>**WK-4**<br>**Engineering specialist knowledge** | Selected SDGs from SDG - 1 to 17 (relevance as per curriculum) |
| **PLO-3**<br>**Design/Development of Solutions:**<br>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**<br>**Design and development of solutions** | **WK-5**<br>**Engineeringdesign and operations** | SDG-1, 2, 3, 6, 10, 11, 12, 13, 14 (relevance as per curriculum) |

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

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

** Engineering Competencies (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.

## 10. 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
    - Multi-disciplinary Engineering/Specialty Courses: Minimum 06 Credit Hours
    - HEIs have 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 curriculum matrix covering the defined knowledge and attitude profiles should therefore be composed of non-engineering domain (humanities, math, management and natural sciences), and engineering domain with Civil 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 |

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

| | | |
|---|---|---|
| WK-2/<br>WK-4/<br>WK-5/<br>WK-6/<br>WK-7/<br>WK-8 | **Innovative and Critical Thinking (under relevant courses):**<br>- Complex Problem Solving<br>- Complex Engineering Activities<br>- Semester Project<br>- Case Studies<br>- Open Ended Labs<br>- 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 $3^{rd}$ to $4^{th}$ 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 inline 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 industry after graduation.
- **Community Service:** Community service aims to familiarize students with solving the problems of the community on the volunteer basis.
- Any other activity deems important for any engineering discipline, e.g. survey camp for civil engineering

- **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 as 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 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 department to formulate their own programs according to the industrial needs, emerging trends and recent developments in the field of Civil Engineering. The HEIs have flexibility to incorporate changes in the proposed curriculum within given range of credit hours for engineering and non-engineering domain.

# 11. Framework for Bachelor of Civil Engineering Curriculum

| Knowledge Profile (WK-1 to WK-9) | Knowledge Area | Sub Area | Course Title | Theory | Lab | Credit Hours | Total |
|---|---|---|---|---|---|---|---|
| **General Education / Non-Engineering Domain** | | | | | | | |
| WK-1/ WK-5/ WK-7/ WK-9 | **Humanities** | English | Functional English ** | 3 | 0 | 3 | 6 |
| | | | Expository Writing ** | 3 | 0 | 3 | |
| | | Culture | Ideology and Constitution of Pakistan ** | 2 | 0 | 2 | 6 |
| | | | Islamic Studies/ Ethics** | 2 | 0 | 2 | |
| | | | Arts & Humanities Elective* | 2 | 0 | 2 | |
| | | Social Sciences | Social Science Elective*** | 2 | 0 | 2 | 4 |
| | | | Civics & Community Engagements ** | 2 | 0 | 2 | |
| | **Management Sciences** | Professional Practice | Project Management *** | 2 | 0 | 2 | 4 |
| | | | Entrepreneurship ** | 2 | 0 | 2 | |
| | **Computer Sciences** | Basic Computing | Applications of ICT ** | 2 | 1 | 3 | 3 |
| WK-1 WK-2 | **Natural Sciences** | Mathematics | Quantitative Reasoning-I | 3 | 0 | 3 | 6 |
| | | | Quantitative Reasoning-II | 3 | 0 | 3 | |
| | | | Advanced Calculus | 3 | 0 | 3 | 9 |
| | | | Applied Mathematics | 3 | 0 | 3 | |
| | | | Numerical Analysis | 3 | 0 | 3 | |
| | | Physics | Applied Physics and Electro-Mechanical Fundamentals | 2 | 1 | 3 | 3 |
| **Total (General Education / Non-Engineering Domain)** | | | | | | | **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** | **Knowledge Area** | **Subject Area** | **Name of Course** | **Th** | **Lab** | **C. Hrs** | **Total Credits** |
| WK-2/ WK-4/ WK-5 | **Advanced Computer and Information Sciences** | ICT/AI/ Data Science/ Cyber Security | Computer Programming | 2 | 1 | 3 | 6 |
| | | | Civil Engg. Drawing & Graphics | 1 | 2 | 3 | |
| WK-3/ WK-2 | **Engineering Foundation Courses** | | Civil Engg Materials | 2 | 1 | 3 | 24 |
| | | | Engineering Drawing | 1 | 2 | 3 | |
| | | | Engineering Surveying | 2 | 1 | 3 | |
| | | | Mechanics of Solids-I | 2 | 1 | 3 | |
| | | | Structural Analysis-I | 3 | 0 | 3 | |
| | | | Soil Mechanics | 2 | 1 | 3 | |
| | | | Fluid Mechanics | 2 | 1 | 3 | |
| | | | Engineering Mechanics | 2 | 1 | 3 | |
| WK-4/ WK-2/ WK-1 | **Engineering Breadth Courses** | | Advanced Engineering Surveying | 2 | 1 | 3 | 22 |
| | | | Advanced Fluid Mechanics | 2 | 1 | 3 | |
| | | | Reinforced Concrete Design-I | 3 | 1 | 4 | |
| | | | Environmental Engineering | 2 | 1 | 3 | |
| | | | Structural Analysis-II | 3 | 0 | 3 | |
| | | | Quantity & Cost Estimation | 2 | 1 | 3 | |
| | | | Engineering Hydrology | 2 | 1 | 3 | |
| WK-5/ WK-6 | **Major Based Core (Depth)** | | Reinforced Concrete Design- II | 3 | 1 | 4 | 22 |
| | | | Mechanics of Solids-II | 2 | 1 | 3 | |
| | | | Geotechnical Engineering | 3 | 1 | 4 | |
| | | | Foundation Engineering | 2 | 0 | 2 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Pavement Analysis & design | 2 | 1 | 3 | |
| | | | Hydraulics Engineering | 2 | 1 | 3 | |
| | | | Irrigation Engineering | 2 | 1 | 3 | |
| WK-1/ WK-2/ WK-3/ WK-4/ WK-7/ WK-9 | **Multi-Disciplinary Engineering / Specialty Courses** | | Geology for Engineers | 2 | 0 | 2 | 7 |
| | | | Architecture & Town Planning | 2 | 0 | 2 | |
| | | | Modelling & Simulation | 1 | 1 | 2 | |
| | | | Occupational Health & Safety | 1 | 0 | 1 | |
| | | | Community Service | - | - | - | *NC |
| | | | Survey Camp | - | - | - | *NC |
| | **Flexible Engineering/ Non-Engineering Courses** | | Construction Engineering | 2 | 0 | 2 | 8 |
| | | | Highway & Traffic Engineering | 2 | 0 | 2 | |
| | | | Steel Structures | 2 | 0 | 2 | |
| | | | Geo Informatics | 1 | 1 | 2 | |
| WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-9 | **Final Year Design Project (FYDP)** | | FYDP Part-I | 0 | 3 | 3 | 6 |
| | | | FYDP Part-II | 0 | 3 | 3 | |
| WK-6/ WK-7/ WK-9 | **Industrial Training** | 6-8 weeks Industrial Training (Non-Credit) | | | | | **Qualifying & Mandatory** |
| | | | | | | **Total (Engineering Domain)** | **95** |
| | | | | | | **Total (Credit Hours)** | **136** |

Note: 1. * NC (Non-Credit) and will be offered during Summer/ Semester Break.

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

## 12. Scheme of Studies for Bachelor of Civil Engineering Curriculum

| 1st Year | | | | |
|---|---|---|---|---|
| **First Semester** | | | | |
| **S. No.** | **Course Title** | **(Credit Hours)** | | **Total** |
| | | **Theory** | **Lab** | **Cr. Hrs.** |
| 1 | Civil Engineering Materials | 2 | 1 | 3 |
| 2 | Applied Physics & Electro- Mechanical Fundamentals | 2 | 1 | 3 |
| 3 | Engineering Drawing | 1 | 2 | 3 |
| 4 | Functional English | 3 | 0 | 3 |
| 5 | Quantitative Reasoning-I | 3 | 0 | 3 |
| 6 | Applications of ICT | 2 | 1 | 3 |
| | **Total** | **13** | **5** | **18** |
| | | | | |
| **Second Semester** | | | | |
| **S. No.** | **Course Title** | **(Credit Hours)** | | **Total** |
| | | **Theory** | **Lab** | **Cr. Hrs.** |
| 1 | Engineering Surveying | 2 | 1 | 3 |
| 2 | Geology for Engineers | 2 | 0 | 2 |
| 3 | Islamic Studies/ Ethics | 2 | 0 | 2 |
| 4 | Engineering Mechanics | 2 | 1 | 3 |
| 5 | Ideology and Constitution of Pakistan | 2 | 0 | 2 |
| 6 | Computer Programming | 2 | 1 | 3 |
| 7 | Quantitative Reasoning-II | 3 | 0 | 3 |
| | **Total** | **15** | **3** | **18** |

| 2nd Year | | | | |
|---|---|---|---|---|
| **Third Semester** | | | | |
| **S. No.** | **Course Title** | **(Credit Hours)** | | **Total** |
| | | **Theory** | **Lab** | **Cr. Hrs.** |
| 1 | Civil Engg. Drawing & Graphics | 1 | 2 | 3 |
| 2 | Advanced Engineering Surveying | 2 | 1 | 3 |
| 3 | Fluid Mechanics | 2 | 1 | 3 |
| 4 | Mechanics of Solids-I | 2 | 1 | 3 |
| 5 | Structural Analysis-I | 3 | 0 | 3 |
| 6 | Advanced Calculus | 3 | 0 | 3 |
| | **Total** | **13** | **5** | **18** |
| | | | | |
| **Fourth Semester** | | | | |
| **S. No.** | **Course Title** | **(Credit Hours)** | | **Total** |
| | | **Theory** | **Lab** | **Cr. Hrs.** |
| 1 | Construction Engineering | 2 | 0 | 2 |
| 2 | Arts and Humanities Elective* | 2 | 0 | 2 |
| 3 | Applied Mathematics | 3 | 0 | 3 |
| 4 | Mechanics of Solids-II | 2 | 1 | 3 |
| 5 | Soil Mechanics | 2 | 1 | 3 |
| 6 | Social Science Elective** | 2 | 0 | 2 |
| 7 | Quantity & Cost Estimation | 2 | 1 | 3 |
| 8 | Survey Camp | - | - | ***NC |
| | **Total** | **15** | **3** | **18** |

| 3rd Year | | | | |
|---|---|---|---|---|
| **Fifth Semester** | | | | |
| **S. No.** | **Course Title** | **(Credit Hours)** | | **Total Cr. Hrs.** |
| | | **Theory** | **Lab** | |
| 1 | Numerical Analysis | 3 | 0 | 3 |
| 2 | Advanced Fluid Mechanics | 2 | 1 | 3 |
| 3 | Expository Writing | 3 | 0 | 3 |
| 4 | Geotechnical Engineering | 3 | 1 | 4 |
| 5 | Reinforced Concrete Design-I | 3 | 1 | 4 |
| | **Total** | **14** | **3** | **17** |
| | | | | |
| **Sixth Semester** | | | | |
| **S. No.** | **Course Title** | **(Credit Hours)** | | **Total Cr. Hrs.** |
| | | **Theory** | **Lab** | |
| 1 | Reinforced Concrete Design-II | 3 | 1 | 4 |
| 2 | Environmental Engineering | 2 | 1 | 3 |
| 3 | Structural Analysis-II | 3 | 0 | 3 |
| 4 | Engineering Hydrology | 2 | 1 | 3 |
| 5 | Highway & traffic Engineering | 2 | 0 | 2 |
| 6 | Civics and Community Engagement | 2 | 0 | 2 |
| 7 | Community Service | - | - | ***NC |
| 8 | Internship (6-8 weeks) mandatory and qualifying | - | - | ***NC |
| | **Total** | **14** | **3** | **17** |

| Final Year | | | | |
|---|---|---|---|---|
| **Seven Semester** | | | | |
| **S. No.** | **Course Title** | **(Credit Hours)** | | **Total** |
| | | **Theory** | **Lab** | **Cr. Hrs.** |
| 1 | Foundation Engineering | 2 | 0 | 2 |
| 2 | Pavement Analysis & design | 2 | 1 | 3 |
| 3 | Modelling & Simulation | 1 | 1 | 2 |
| 4 | Hydraulics Engineering | 2 | 1 | 3 |
| 5 | Project Management | 2 | 0 | 2 |
| 6 | FYDP Part-I | 0 | 3 | 3 |
| | **Total** | **9** | **6** | **15** |
| | | | | |
| **Eight Semester** | | | | |
| **S. No.** | **Course Title** | **(Credit Hours)** | | **Total** |
| | | **Theory** | **Lab** | **Cr. Hrs.** |
| 1 | Irrigation Engineering | 2 | 1 | 3 |
| 2 | Geoinformatics | 1 | 1 | 2 |
| 3 | Steel Structures | 2 | 0 | 2 |
| 4 | Architecture & Town Planning | 2 | 0 | 2 |
| 5 | Occupational Health & Safety | 1 | 0 | 1 |
| 6 | Entrepreneurship | 2 | 0 | 2 |
| 7 | FYDP Part-II | 0 | 3 | 3 |
| | **Total** | **10** | **5** | **15** |

| * List of Arts and Humanities Electives (2+0) | ** List of Social Science Electives (2+0) |
|---|---|
| • Communication and Presentation Skills<br>• Beginners Spanish<br>• Elementary Arabic<br>• Elementary French<br>• Elementary Chinese<br>• History<br>• Philosophy<br>• Professional Ethics<br>• Any other relevant course / language decided by the HEI as per requirement | • Sociology for Engineers<br>• Sociology<br>• Social phycology<br>• Critical Thinking<br>• Human Resource Management<br>• Organizational Behavior<br>• Engineering Law<br>• Engineering Economics<br>• Any other relevant course decided by the HEI as per requirement |

Note: *** NC (Non-Credit) and will be offered during Summer/ Semester Break.

## 13. Mathematics Curriculum Review and Development for Bachelor of Civil Engineering

Following the Higher Education Commission (HEC) UG Education Policy for Non-Engineering Domains, the Pakistan Engineering Council (PEC) mandates the inclusion of both **Quantitative Reasoning-I and Quantitative Reasoning-II** courses in all engineering programs. As a result, an additional 2 to 3 mathematics courses must be selected from the remaining 7 options. Given the importance of the listed math courses in the HEC course design, the challenge lies in strategically choosing a limited number of courses while ensuring comprehensive coverage of essential topics. Consequently, the subcommittee for Bachelor of Civil Engineering program faces the task of developing a syllabus that either adheres to the original content of specified courses, combines principles from multiple courses, or integrates unrelated courses.

The PEC Sub-Committee proposes the retention of **Quantitative Reasoning-I (QR-I)** and **Quantitative Reasoning-II (QR-II)** as mandatory courses in alignment with HEC requirements. The third course, titled **Advanced Calculus**, is crafted by merging the principles of Calculus and **Analytical Geometry** with **Multivariate Calculus.** This integration aims to provide a deeper understanding of the subject by exploring topics involving both single and multiple variables. For example, the study of limits begins with a focus on a single variable and extends to multivariable scenarios, enhancing conceptual understanding across both domains.

The fourth course, **Applied Mathematics**, strategically combines **Linear Algebra** and **Differential Equations** while emphasizing practical applications of mathematical principles. This integration seeks to bridge the gap between theoretical knowledge and real-world engineering challenges, equipping students with a robust skill set to effectively apply mathematical concepts in civil engineering. The fifth math course, **Numerical Analysis**, is recommended in its original form. Probability & Statistics is omitted from consideration as its pertinent contents are adequately covered in QR-I and QR-II. **Complex Variables & Transforms** is deemed irrelevant to the Bachelor of Civil Engineering program and is therefore not included in the proposed curriculum.

In this regard, the contribution of all relevant members/ experts particularly Engr. Prof. Dr. Waseem Khaliq & Dr. Faisal Yousafzai of MCE, (NUST) Risalpur was highly acknowledged and appreciated by the ECRDC Civil & Allied Disciplines.

## 14. Program Specific Laboratories

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

- Materials and Concrete Lab
- Mechanics of Solids Lab
- Engineering Mechanics Lab
- Fluid Mechanics and Hydraulics Labs
- Hydrology Lab
- Environmental Engineering Lab
- Soil Mechanics and Geotechnical Engineering Labs
- Transportation Lab
- Drawing Hall
- Survey Store
- Computer Lab with sufficient systems having State-of-the-art each specialty Softwares frequently used in Industry
- Project & Research Lab

- ***"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."***

## 15. 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.

## 15.1 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:<br>1. Apply enhanced English communication skills through effective use of word choices, grammar and sentence structure.<br>2. Comprehend a variety of literary / non-literary written and spoken texts in English.<br>3. Effectively express information, ideas and opinions in written and spoken English.<br>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:**<br>• 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 APLICATIONS 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

## 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.

# 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.

| *** List of Arts and Humanities Electives (2+0)** |
|---|
| • Communication and Presentation Skills<br>• Beginners Spanish<br>• Elementary Arabic<br>• Elementary French<br>• Elementary Chinese<br>• History<br>• Philosophy<br>• Professional Ethics<br>• Any other relevant course / language decided by the HEI as per requirement |

## COMMUNICATION AND PRESENTATION SKILLS

Credits: 02
Pre-Requisite: Nil

### COURSE LEARNING OUTCOME

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 OUTCOME

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

## ASSESSMENT:

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

## 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 OUTCOME

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 OUTCOME

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 OUTCOME

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 OUTCOME

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 OUTCOME

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 OUTCOME

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

| ** List of Social Science Electives (2+0) |
|---|
| • Sociology for Engineers<br>• Sociology<br>• Social phycology<br>• Critical Thinking<br>• Human Resource Management<br>• Organizational Behavior<br>• Engineering Law<br>• Engineering Economics<br>• 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, Co mmunity 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:

**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.APhilosophyofTechnology:FromTechnical Artefacts to Socio technical systems.
7. Mitcham,C.,andMunoz,D.2010.HumanitarianEngineering.MorganandClaypoolPublishers. 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

## 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,

**SOCIOLOGY**

Credits: 02
Pre-Requisite: Nil

## COURSE LEARNING OUTCOMES

- To introduce the necessary subject knowledge and understanding required for the successful study of Sociology and related Social Science disciplines at undergraduate.
- To develop skills of application, analysis and evaluation in the context of the study of Social Science.
- To develop a knowledge and understanding of sociology both at a global and national level.
- To introduce the planning and organization skills necessary to develop as independent, autonomous learners.
- 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.

## 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.
3. Analyze human psychology through the lens of Quran and Sunnah.
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

Quizzes, Assignments, Mid Exam, Final Exam

## 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

Credits: 02
Pre-Requisite: Nil

## COURSE LEARNING OUTCOMES

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

- Apply economic principles to analyze engineering projects.
- Utilize cost analysis methods to evaluate project feasibility and make decisions.
- Manage risks and uncertainties in engineering economic assessments.
- Consider economic factors such as inflation and taxation in decision making.
- Integrate ethical and sustainable considerations into economic analyses.

## COURSE CONTENT/COURSE OUTLINE

1. **Introduction**

- Engineering Costs
- Estimation Models & Cash Flow Diagram
- Life cycle cost

2. **Time value of Money**

- Time value of money, equivalence, use of spread sheet, simple and compound interest
- Uniform series & Arithmetic & geometric gradient
- Nominal & effective, continuous compounding Economic criteria,
- Present Worth, future worth and annuity

3. **Rate of Return**

- Minimum acceptable rate of return(MARR),
- Internal rate of return, External rate of return
- Choosing the best alternative
- Incremental Analysis

4. **Benefits and Cost ratio and Payback period**

- Benefit and cost ratio (B/C Ratio), discounted benefit and cost ratio
- Simple payback period, discounted payback period
- Sensitivity & breakeven analysis
- Principle of comparative advantage

5. **Depreciation**

- Depreciation
- Depreciation using Unit of Production

- Depreciation using straight line method
- Depreciation using Depletion

**6. Taxes**
- Income Taxes, After tax RoR
- Replacement analysis
- Design life, salvage value
- Up gradation Vs replacement

**7. Risk and Uncertainty**
- Estimation of future events
- Monte Carlo Simulation
- Bayes theorem

**8. Concepts of Imports and Exports**
- Basic concepts of import and export
- Dumping and anti-dumping and related laws

**9. Teaching Methodology**
- Lecturing
- Written Assignments
- Presentation

## ASSESSMENT

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

## SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. William G. Sullivan and Elin M. Wicks, Estimation of future events
2. N. M. Fraser and E. M. Jewkes, Engineering Economics: Financial Decision Making for Engineers
3. D. G. Newnan, J. Whittaker, T. G. Eschenbach and J. P. Lavelle, Engineering Economic Analysis
4. J. Tarquin, L. T. Blank, Engineering Economy, McGraw Hill

# 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

# 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).

# 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.<br>2. "Entrepreneurship: Theory, Process, and Practice" by Donald F. Kuratko.<br>3. "New Venture Creation: Entrepreneurship for the 21st Century" by Jeffry A. Timmons, Stephen Spinelli Jr., and Rob Adams.<br>4. "Entrepreneurship: A Real-World Approach" by Rhonda Abrams.<br>5. "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries.<br>6. "Effectual Entrepreneurship" by Stuart Read, Saras Sarasvathy, Nick Dew, Robert Wiltbank, and Anne-Valérie Ohlsson. |

# 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

# QUANTITATIVE REASONING (I)

UGE Policy V 1.1: General Education Course

Credits: 03
Pre-Requisite: Nil

## DESCRIPTION

Quantitative Reasoning (I) is an introductory-level undergraduate course that focuses on the fundamentals related to the quantitative concepts and analysis. The course is designed to familiarize students with the basic concepts of mathematics and statistics and to develop students' abilities to analyze and interpret quantitative information. Through a combination of theoretical concepts and practical exercises, this course will also enable students cultivate their quantitative literacy and problem-solving skills while effectively expanding their academic horizon and breadth of knowledge of their specific major / field of study.

## COURSE LEARNING OUTCOMES

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

1. Understand fundamentals of mathematics and basic statistical concepts;
2. Interpret data presented in various formats including but not limited to tables, graphs, charts, and equations etc.

## COURSE OUTLINE

1. **Numerical Literacy:**
    - Number system and basic arithmetic operations;
    - Units and their conversions, dimensions, area, perimeter and volume;
    - Rates, ratios, proportions and percentages;
    - Types and sources of data;
    - Measurement scales;
    - Tabular and graphical presentation of data;
    - Quantitative reasoning exercises using number knowledge.
2. **Fundamental Mathematical Concepts:**
    - Basics of geometry (lines, angles, circles, polygons etc.);
    - Sets and their operations;
    - Relations, functions, and their graphs;
    - Exponents, factoring and simplifying algebraic expressions;
    - Algebraic and graphical solutions of linear and quadratic equations and inequalities;

- Quantitative reasoning exercises using fundamental mathematical concepts.

**3. Fundamental Statistical Concepts:**

- Population and sample;
- Measures of central tendency, dispersion and data interpretation;
- Rules of counting (multiplicative, permutation and combination);
- Basic probability theory;
- Introduction to random variables and their probability distributions;
- Quantitative reasoning exercises using fundamental statistical concepts.

## SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Quantitative Reasoning: Tools for Today's Informed Citizen" by Bernard L. Madison, Lynn and Arthur Steen.
2. "Quantitative Reasoning for the Information Age" by Bernard L. Madison and David M. Bressoud.
3. "Fundamentals of Mathematics" by Wade Ellis.
4. "Quantitative Reasoning: Thinking in Numbers" by Eric Zaslow.
5. "Thinking Clearly with Data: A Guide to Quantitative Reasoning and Analysis" by Ethan Bueno de Mesquita and Anthony Fowler.
6. "Using and Understanding Mathematics: A Quantitative Reasoning Approach" by Bennett, J. O., Briggs, W. L., & Badalamenti, A.
7. "Discrete Mathematics and its Applications" by Kenneth H. Rosen.
8. "Statistics for Technology: A Course in Applied Statistics" by Chatfield, C.
9. "Statistics: Unlocking the Power of Data" by Robin H. Lock, Patti Frazer Lock, Kari Lock Morgan, and Eric F. Lock.

# QUANTITATIVE REASONING (II)

UGE Policy V1.1: General Education Course

Credits: 03

Pre-Requisite: Quantitative Reasoning (I)

## DESCRIPTION

Quantitative Reasoning (II) is a sequential undergraduate course that focuses on logical reasoning supported with mathematical and statistical concepts and modeling / analysis techniques to equip students with analytical skills and critical thinking abilities necessary to navigate the complexities of the modern world. The course is designed to familiarize students with the quantitative concepts and techniques required to interpret and analyze numerical data and to inculcate an ability in students the logical reasoning to construct and evaluate arguments, identify fallacies, and think systematically. Keeping the pre-requisite course of Quantitative Reasoning (I) as its base, this course will enable students further their quantitative, logical and critical reasoning abilities to complement their specific major / field of study.

## COURSE LEARNING OUTCOMES

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

1. Understand basic quantitative modeling and analyses;
2. Apply logical reasoning skills to solve quantitative modeling problems;
3. Evaluate quantitative information to make evidence based decisions through appropriate computational tools.

## COURSE OUTLINE

**1. Logic, Logical and Critical Reasoning:**

- Introduction and importance of logic;
- Inductive, deductive and abductive approaches of reasoning;
- Propositions, arguments (valid; invalid), logical connectives, truth tables and propositional equivalences;
- Logical fallacies;
- Venn Diagrams;
- Predicates and quantifiers;
- Quantitative reasoning exercises using logical reasoning concepts and techniques

**2. Mathematical Modeling and Analyses**
- Introduction to deterministic models;
- Use of linear function for modeling in real-world situations;
- Modeling with the system of linear equations and their solutions;
- Elementary introduction to derivatives in mathematical modeling;
- Linear and exponential growth and decay models;
- Quantitative reasoning exercises using mathematical modeling.

**3. Statistical Modeling and Analyses**
- Introduction to probabilistic models;
- Bivariate analysis, scatter plots;
- Simple linear regression model and correlation analysis;
- Basics of estimation and confidence interval;
- Testing of hypothesis (z-test; t-test);
- Statistical inference in decision making;
- Quantitative reasoning exercises using statistical modeling.

## SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. "Using and Understanding Mathematics: A Quantitative Reasoning Approach" by Bennett, J. O., Briggs, W. L., & Badalamenti, A.
2. "Discrete Mathematics and its Applications" by Kenneth H. Rosen.
3. "Discrete Mathematics with Applications" by Susanna S. Epp.
4. "Applied Mathematics for Business, Economics and Social Sciences" by Frank S Budnick.
5. "Elementary Statistics: A Step by Step Approach" by Allan Bluman.
6. "Introductory Statistics" by Prem S. Mann.
7. "Applied Statistical Modeling" by Salvatore Babones.
8. "Barrons SAT" by Sharvon Weiner Green, M.A and Ira K.Wolf.

# ADVANCED CALCULUS

Credit Hours: 3
Pre-Requisites: Nil

## DESCRIPTION

This course provides a comprehensive exploration of the geometry of Euclidean space, coupled with a detailed study of calculus concepts and applications. Students will investigate vector analysis, functions, limits, continuity, differentiation, integration, and sequences and series. The course emphasizes the geometric interpretation of mathematical concepts and their practical applications, making it suitable for students pursuing studies in civil engineering.

## COURSE LEARNING OUTCOMES

Upon completing the course, students will be able to:
1. Analyze vectors, scalars, and vector products for spatial geometry.
2. Apply the mathematical concepts for real-life problems solving.

## COURSE OUTLINE (THEORY)

**1. The Geometry of Euclidean Space**
- Review of vectors, scalars and vector products, equations of straight line and plane.

**2. Functions, Limit and Continuity**
- Functions of single and several variables, techniques of finding limits and continuity
- Parametric Representation of Curves
- Tangent and Normal to the curve.

**3. Differentiation**
- Introduction to ordinary and partial derivatives
- Chain Rule with single and several variables
- Techniques of finding ordinary derivatives as examples of related rates.
- Directional Derivatives

**4. Applications of Derivatives**
- Extrema of functions of single variable
- First and second derivative tests
- Optimization problems of functions of single variable
- Extrema of functions of several variables.

- Optimization problems of functions of several variables (Lagrange multipliers)

**5. Integration**

- Introduction to integration
- Properties and techniques of integration
- Definite integrals
- Double integrals
- Change of order of integration
- Triple integrals

**6. Applications of Integration**

- Area under and between the curves
- Volumes of solids of revolution by disk and Washer method.
- Work Done
- Moment of Inertia

**7. Infinite Sequence and Series**

- Power series
- Maclaurin and Taylor series and their applications.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

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

**Suggested Assessment Methods Theory**

One-hour test(s)/Mid-semester exam (s), 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
5. George B. Thomas, Jr. and Ross L. Finney, Calculus and Analytic Geometry.

# APPLIED MATHEMATICS

Credit Hours: 3
Pre-Requisites: Advanced Calculus

## DESCRIPTION

This course covers essential mathematical techniques for engineering applications, beginning with the System of Linear Equations and Applications with real-world civil engineering case studies. The Eigenvalues and Eigenvectors explore the concepts and applications of linear algebra in constructing curves, surfaces. Linear Programming introduces optimization principles. Basic Concepts and Modeling covers linear/non-linear differential equations, initial/boundary value problems. Analytical methods for first-order ODEs, variable separable, homogeneous, exact, and linear equations are addressed, alongside applications such as mixing problems and temperature prediction. The subsequent section investigates the analytical methods for second-order ODEs, covering homogeneous, non-homogeneous, and Cauchy-Euler equations, with practical applications in earthquake modeling and bridge collapse scenarios. The course concludes with an exploration of Laplace Transform and its applications in solving second-order ODEs.

## COURSE LEARNING OUTCOMES

Upon completion of this course, students will be able to:

1. Comprehend the basic mathematical concepts.
2. Apply the mathematical concepts for problem solving.

## COURSE OUTLINE (THEORY)

**1. System of Linear Equations and Applications**

- Overview of the linear system of equations, Cases of unique solution, no solution, and infinite solutions.
- Echelon form, Gauss elimination method.
- Relevant engineering case studies such as network analysis, traffic flows, finding max stress in compound cylinders, and applications of linear systems in force balancing of structures.

**2. Eigenvalues and Eigenvectors**

- Eigenvalues and eigenvectors
- Applications of linear Algebra: Constructing curves and surfaces.

3. **Linear Programming**

- Introduction to linear programming, Optimization, Graphical Method, Simplex Method, and Optimization problems in Engineering
- Transportation Model, Assignment model, Transshipment Model

4. Basic Concepts and Modeling

- Degree and order of ODEs, Linear/Non-linear differential equations, Solutions of differential equations, Initial and Boundary value problems.

5. Analytical methods of solution for first order ODEs

- Variable separable, Homogenous equations, Solution of the related ODE models by these methods.
- Exact equations, Integrating factor, Linear equations, and related examples, Bernoulli Equations.

6. Mathematical Methods of Solution for First Order ODEs

- Formulation of first-order ODEs: Mixing problems and free fall motion, finding the temperature of a building and logistic equations, etc.

7. Analytical methods of solution for second order ODEs

- Homogenous linear ODEs, Method of reduction of order, Wronskian determinant to check independence of the solution and related examples.
- Cauchy-Euler equations and related examples, non-homogenous linear ODEs, Method of variation of Parameters, and related examples.

8. Mathematical Methods of Solution for Second-Order ODEs

- Earthquake model of single-story building and bridge collapse problems etc.

9. Laplace Transform

- Laplace transforms, Inverse Laplace transform, shifting theorem.
- Laplace transform of derivatives, Solution of second order ODE by Laplace transform

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

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

**Suggested Assessment Methods Theory**

One-hour test(s)/Mid-semester exam (s), 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.
3. Advanced Engineering Mathematics by Erwin Kreyzig, John Wiley & Sons Inc. Latest Edition.
4. Differential Equation with Boundary Value problems by D. G. Zill, M. R Cullen Latest Edition, Brooks/Cole Publishers.
5. A First Course on Differential Equations with Modelling Applications by D. G. Zill, Latest Edition, Brooks/Cole Publishers.
6. An Introduction to Mathematical Modelling by Bender, E.A., Latest Edition, Wiley, New York.

# NUMERICAL ANALYSIS

Credit Hours: 3
Pre-Requisites: Nil

## DESCRIPTION

This course provides a concise exploration of essential topics in numerical analysis with a focus on practical applications in engineering. Topics include error analysis, interpolation methods, numerical differentiation and integration techniques, solutions for linear systems, iterative methods for linear and nonlinear equations, numerical methods for solving initial and boundary value problems, computing eigenvalues, and optimization methods. Relevant engineering case studies are integrated throughout, offering students a robust understanding of numerical methods and their application in solving real-world engineering problems.

## COURSE LEARNING OUTCOMES

**Upon completion of this comprehensive numerical analysis course, students will be able to:**

1. Apply numerical methods for the solutions of linear/nonlinear equations
2. Identify the function from the numerical data to find the best fit curve
3. Computing eigenvalues and delve into numerical optimization techniques, with practical applications illustrated through case studies

## COURSE OUTLINE (THEORY)

**1. Error Analysis and Interpolation**

- Error analysis, Types of error, Sources of error, Norms of vectors and matrices
- Interpolation: Newton forward and backward difference formula for interpolation, Central difference interpolation formulae, Lagrange's interpolation, Error in interpolation, Relevant engineering case studies

**2. Numerical Differentiation and Integration**

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

**3. Methods of solution a system of Linear Equations**

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

**4. Iterative Methods for Linear and Nonlinear Equations**

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

**5. Numerical Methods for IVPs**

- Euler's method and its variations.
- Runge-Kutta methods of order 2 and 4.
- Linear multistep methods, Numerical solution of system of ODEs
- Applications in engineering: Some relevant case studies

**6. Numerical Methods for Computing Eigenvalues**

- Eigenvalues and Eigenvectors of matrix: power method,
- Inverse power method.
- Applications of eigenvalues in civil engineering.

**7. Numerical Optimization**

- Unconstrained Optimization,
- Lagrange Multipliers,
- Method of steepest descent
- Applications of optimization in civil engineering

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

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

**Suggested Assessment Methods Theory**

One-hour test(s)/Mid-semester exam (s), 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 Scientists and Engineers by R.W. Hamming (Latest Edition).
3. Numerical Methods for Engineers by Steven C. Chapra and R. P. Canale (Latest Edition).

# APPLIED PHYSICS AND ELECTRO-MECHANICAL FUNDAMENTALS

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

## DESCRIPTION

This course equips the students with the applied concepts of Applied Physics and Electro-Mechanical Fundamentals. By the course completion, students would have developed a good understanding of the fundamentals covering vectors, applied mechanics, electro-statics, waves and oscillations, electrical elements and circuits, relevant electronics in Civil Engineering testing, thermodynamics, HVAC, and renewable energy systems.

## COURSE LEARNING OUTCOMES

Upon completion of this comprehensive course, students will be able to:

1. UNDERSTAND concepts related to basic physics and electro-mechanical engineering.
2. APPLY fundament concepts of physics and electro-mechanical engineering.

## COURSE OUTLINE (THEORY)

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's Laws and their Applications (Simple Accelerometer, Banked Curve, and Rotor)
- Frictional Forces and determination of Co-efficient of Friction, Work-Energy Theorem, applications of the law of Conservation of Energy
- Angular Momentum
- Centre of Mass of two particles, many particles, and Solid Object
- Rotational Inertia of Solid Bodies

3. **Waves and Oscillations:**
- Simple Harmonic Oscillator, Damped Harmonic Oscillation

- Forced Oscillation, and Resonance, Types of Waves, and Superposition Principle
- Wave Speed on a stretched string
- Wave equation, Energy & Power of a Wave

**4. 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

**5. Electrical Elements and Circuits (Demonstrative / Labs)**

- Review of electric current, voltage, power, and energy
- Ohm's law, inductance, capacitance
- AC single and poly-phase system
- DC machines, AC synchronous machines, AC induction machines, transformers converting machines.
- Brief introduction to motors and generators

**6. Electronics (Demonstrative / Labs)**

- Electronic strain gauges and transducers
- LDTs and LVDTs
- Diode transistor and simple rectifier circuit.
- Electrical know-how related to experimental design instruments like corrosion rate measurements.

**7. Thermodynamics (Demonstrative / Labs)**

- Review of Laws of Thermodynamics covering fundamentals of heat transfer, conduction, convection, and radiation.
- Thermal conductivity, specific heat, and overall heat transfer coefficients

**8. Heating, Ventilation and Air Conditioning (HVAC)**

- Introduction to HVAC components.
- Heating and cooling load and its calculations
- Comfort charts and outline of air-conditioning systems

## LABS/ PRACTICALS

The course labs/practicals should be defined and synchronized with the course outline.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Laboratory Experiments
Written Assignments
Guest Speaker
Industrial/Field Visits

**Suggested Assessment Methods Theory**

One-hour test(s)/Mid-semester exam (s)
Quiz tests, Assignments, Lab Assessments, Project Reports/Term Paper/Presentations/Case Studies relevant to civil engineering discipline
Final Exam

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Physics, By: Halliday, Resnick & Krane, Edition: 10th Edition (or latest edition).
2. University Physics, BY: Hugh D. Young and R.A. Freedman, (latest edition).
3. Physics for Scientist & Engineers, by Serway, Jewett (latest edition).
4. Basic Electrical Engineering by Del Toro, Prentice Hall (latest edition).
5. Basic Electrical Technology by T.K. Nagasarkar & Suhkija, (latest edition).
6. Theraja, B.L. Electrical Technology, S. Chand publishing (latest edition).

## 15.2 Engineering Domain

### COMPUTER PROGRAMMING

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

| DESCRIPTION |
|---|
| To give students a detailed understanding of learning computer languages and Microsoft Office. To develop skills of computer programming and its applications in elementary civil engineering problems. |
| **COURSE LEARNING OUTCOMES** |
| By the end of this course, students will be able to:<br>1. DESCRIBE basic concepts of computer programming.<br>2. ANALYZE computing problems related to civil engineering and choose the best possible solution<br>3. DEVELOP computer programs involving arithmetic operations, input/output statements, decision-making statements, loops and functions. |
| **COURSE OUTLINE (THEORY)** |
| 1. Computational Thinking<br>2. Introduction to programming & PYTHON/Matlab/Octave<br>3. Numeric, String and List<br>4. PYTHON/Matlab/Octave variables<br>5. Scripts files<br>6. Functions and Files<br>7. Opening Excel/MAT/text files<br>8. Programming with PYTHON/Matlab/Octave<br>9. Syntax<br>10. Algorithms<br>11. Flow charts<br>12. Conditional operations<br>13. Loops structures<br>14. Advance Plotting and Model Building<br>15. 2D plotting, 3D plotting and Advance 3D plotting<br>16. Symbolic Processing |

17. Numerical Methods for Calculus and Differential Equations in PYTHON/Matlab/Octave
18. Engineering Problems
19. Introduction to MS/Libre Office with advanced applications of MS Excel/Libre Calc

## COURSE OUTLINE (PRACTICAL)

- Introduction (Computer hardware and components, Numbers System, Conversion between bases).
- MS Office.
- Introduction (Integers, Unsigned Integers, Signed Integers, Number Representations and Ranges, ASCII Codes, Algorithms and Flowcharts).
- Introduction to C++ language & Input/output, Operators, Selection.
- Loop (For, while and do-while loops).
- Functions in C++ language.
- Arrays and Strings.
- Introduction to PYTHON/Matlab/Octave.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**
- Lecturing
- Laboratory Demonstration
- Written Assignments
- Guest Speaker

**Suggested Assessment Methods Theorey**
- One hour test(s)/Mid-term
- Quiz tests, Assignments, Project Reports/Term Paper/Presentations
- Final Exam

**Suggested Assessment Methods Practicals**
- In Lab assessment through rubrics
- Post lab assessment through rubrics
- Laboratory Report/Manual
- Laboratory Quiz
- Final Viva Voce Examination

## RECOMMENDED TEXT AND REFERENCE BOOKS

**URLS for book and quick guide:**

1. Recommended Book (online interactive book + downloadable notebook

+ downloadable pdf book slides):
https://fangohr.github.io/teaching/python/book.html

2. This book is enough for guidance.

https://www.python.org/ --> official reference, tutorial, setup, and jobs for python
Or Matlab/Octave books Reference Books Note: These links are worth knowing.

3. https://runestone.academy/runestone/books/published/thinkcspy/index.html -->Reference
Book and for quizzes (interactive version)
4. https://www.ict.ru.ac.za/Resources/cspw/thinkcspy3/thinkcspy3.pdf -->PDF Book
5. https://docs.python.org/3/tutorial/index.html --> Official Python Tutorial
6. https://diveintopython3.net/ --> pdf book for download with its example code
7. https://automatetheboringstuff.com/ --> online book
8. https://developers.google.com/edu/python --> google course and video
9. https://archive.org/details/comp3321/mode/2up --> NSA tutorial on Python.
10. https://programmingwithmosh.com/python/python-3-cheat-sheet/ --> cheatsheet
11. https://perso.limsi.fr/pointal/_media/python:cours:mementopython3-english.pdf->
12. Cheatsheet Or Matlab/Octave books Useful Links:
13. http://rosettacode.org/wiki/Numerical_integration -->numerical integration in various languages
14. pythontutor.com
15. geeksforgeeks.org Or Matlab/Octave links

Video Playlist:

https://www.youtube.com/watch?v=b093aqAZiPU&list=PLlKpQrBME6xKNfcbz2nHyY_anC8BpXRnp

· ---> python for beginners by Kevin Stratvert (Ex MS Developer)

https://www.youtube.com/watch?v=qel0rE0lT3I

· --> Computational Thinking, CS50, Prof. David J. Milan, Harvard University.

https://www.youtube.com/watch?v=fL308_-Kbt0

· --> Taste of Python, CS50 by Prof David J. Milan, Harvard University.Or Matlab/Octave videos

# CIVIL ENGINEERING DRAWING & GRAPHICS

Credit Hours: 1+2=3
Pre-Requisites: Engineering Drawing

## DESCRIPTION

This course will give students a detailed understanding of architectural and civil engineering drawings. The course will provide detailed guidance on the working drawings related to civil engineering projects. Emphasis will be placed on using the frequently used software in industry as well as emerging software to ensure the industry needs.

## COURSE LEARNING OUTCOMES

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

1. DESCRIBE different perspective (functions) of latest version of CAD.
2. EXPLAIN drawing related to different civil engineering projects.
3. PRODUCE civil engineering drawings using CAD software and REVIT tools.

## COURSE OUTLINE (THEORY)

1. **Introduction to Auto Cad, Contour Plan, Infrastructure layout, and Site Plan**

- General introduction to Auto Cad for civil engineering drawings
- Auto Cad different commands of latest version
- 2D and 3D drawings
- General notes
- Contour plan
- Infrastructure layout
- Site plan

2. **Architectural Details of a Simple Two Storied Building**

- Broad prospective about architectural details
- General notes
- Ground floor plan
- First floor plan
- Roof and mumty plan
- Elevations
- Longitudinal and transverse sections

3. **Structural Details of a Simple Two Storied Framed RCC Building**

- Broad prospective about structural RCC details

- General notes
- Foundation plan and related details
- Framing of plinth beams and related details
- Framing of floor beams and related details
- Framing of roof and mumty beams and related details
- Slab reinforcement layout
- Misc. details (stair case and water tank)
- Structural details of boundary wall

**4. Plumbing and Electrical Details of a Simple Two Storied Building**

- Broad prospective about plumbing and electrical details
- General notes for plumbing details
- External water supply and sewerage layout
- Internal water supply and sewerage layout (all plans)
- General notes for electrical details
- Electrification for all plans

**5. Structural Details of Steel Roof Truss**

- Broad prospective about structural steel details
- General notes
- Framing plan
- Truss elevation
- Member cross-sections and connection details

**6. Drawings and Detailing of Hydraulic and Drainage Structures**

- Broad prospective about hydraulic and drainage structural details
- General notes
- Layout plan
- Sectional details

**7. Drawings and Detailing of Highway and Motor way**

- Broad prospective about highway and motorway structural details
- General notes
- Layout plan
- Sectional details

**8. Introduction to Building Information Modeling (BIM)**

- Different functions of BIM tools, e.g. REVIT etc.
- 2D and 3D drawings
- Architectural drawings in REVIT

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

1. Introduction to auto cad, auto cad practice, contour plan, infrastructure layout and site plan.

2. Architectural details of a simple two storied building.
3. Structural details of a simple two storied framed RCC building.
4. Plumbing and electrical details of a simple two storied building.
5. Structural details of steel roof truss.
6. Drawings of hydraulic and drainage structures.
7. Drawings of highway and motorway.
8. BIM (Architectural drawings in REVIT)

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

- Lecturing
- Laboratory Demonstration
- Guest Speaker
- Field Visits

**Suggested Assessment Methods - Theory**

- One hour test(s)/Mid-term
- Quiz tests, Assignments, Project Reports/Term Paper/Presentations with emphasis on PBL/CEP/DP/OEL etc.
- Final Exam

**Suggested Assessment Methods - Practical**

- Laboratory Participation
- Laboratory Report/Manual (Drawing Volume)
- Laboratory Quiz / Viva Voce / Midterm / Final Term

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. M. Chakarborti, Civil Engineering Drawing, UBS Publications, (Latest Edition).
2. Gurcharan Singh, Civil Engineering Drawing, (Latest Edition). Malik Book Dept., Lahore
3. Mastering AutoCAD 2017 and AutoCAD LT 2017 by George Omura with Brian Benton, (latest edition), 2016.
4. Boughton, B. Reinforced Concrete Detailer's Manual (Reference Book), HarperCollins, Publishers Ltd. London

# CIVIL ENGINEERING MATERIALS

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

## DESCRIPTION

This course will give students a detailed understanding of materials commonly employed in civil engineering and construction (steel, aggregates, Portland cement, concrete, masonry, asphalt and asphalt mixtures, wood, Ceramics, and composites) including their methods of manufacture, evaluation of their physical and mechanical properties, and life-cycle impact. The course will provide detailed guidance on material preparation (e.g. material manufacture and concrete and asphalt mix design) and material testing that are commonly employed in the construction and civil engineering disciplines. Emphasis will be placed on selection criteria, design, applications and proper use of these materials.

## COURSE LEARNING OUTCOMES

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

1. EXPLAIN various properties of construction materials.
2. CHOOSE/APPLY appropriate constructional materials for various uses.
3. ANALYZE physical and mechanical properties of various materials.

## COURSE OUTLINE (THEORY)

**1. Materials and their Properties**

- Introduction of materials
- onstruction materials
- Physical, mechanical, and chemical properties
- Electrical and thermal properties

**2. Binding Materials (Cement and Lime)**

- Introduction and manufacture of Ordinary Portland Cement
- Constituents of cement
- Types of cement and their use
- Properties and field tests of cement
- Special cements
- Introduction and preparation of lime
- Setting and hardening of lime
- Applications of lime

- Comparison (cost and characteristics) of lime and cement

**3. Fine & Coarse Aggregates and Stones**

- Definition and introduction of aggregates
- Mechanical and physical properties of aggregates
- Importance and methods of grading of aggregates
- Introduction, types, applications, characteristics of good building stones
- Artificial stones

**4. Cementitious materials**

- Introduction and methods of preparation of paste
- Properties and application of paste
- Introduction and methods of preparation of mortars
- Properties and application of mortars
- Introduction about concrete
- Components and manufacture of concrete, properties of concrete
- Types of concrete

**5. Metals (Steel and Aluminum)**

- Introduction to steel
- Mechanical and physical properties of steel
- Application of steel in civil engineering projects
- Introduction to aluminum
- Mechanical and physical properties of aluminum
- Application of aluminum in civil engineering projects

**6. Ceramics, Bricks and Blocks**

- History and evolution of ceramics
- Manufacture of ceramics
- Properties and applications of ceramics in buildings
- History and evolution of bricks
- Properties and applications of bricks
- Dimensions, manufacture and classification of bricks
- History and evolution of blocks
- Properties and applications of blocks
- Dimensions, manufacture and classification of blocks

**7. Glass and Wood**

- Constituents of glass and methods of manufacture.
- Types, use and significance of glass in civil engineering
- Advantages and drawbacks of glass
- Structure of tree and general characteristics
- Types, seasoning and preservation of wood
- Lamination of wood

**8. Pavement Materials**
- Bitumen
- Asphalt
- Road Metals

**9. Miscellaneous Construction Materials**
- Asbestos, Plaster of Paris, Abrasives
- Rubber, Cork, Plastics
- Paint
- Thermometry and acoustics
- Bamboo
- Natural, artificial, and steel fibers
- Modern Materials (Fiber reinforced polymer etc.)

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

1. To determine consistency, initial and final setting time of various samples of cement and then to discuss the results.
2. To determine the hydraulic properties of lime.
3. To determine different densities of coarse aggregate.
4. To carry out sieve analysis of various samples of coarse aggregates, draw gradation curves for those and to discuss its effects on the properties of concrete.
5. To determine different densities of fine aggregate.
6. To carry out sieve analysis of various samples of fine aggregates, draw gradation curves for those and to discuss its effects on the properties of concrete.
7. To determine the compressive strength of mortar with various mix ratios.
8. To determine water absorption of bricks and to discuss the results.
9. To determine compressive strength of bricks and to discuss the results.
10. To identify various types of wood samples by observation
11. To determine flexural strength of provided samples of timber.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**
- Lecturing
- Laboratory Demonstration
- Written Assignments
- Guest Speaker
- Field Visits

**Suggested Assessment Methods Theory**

- One hour test(s)/Mid-term
- Quiz tests, Assignments, Project Reports/Term Paper/Presentations
- Final Exam
- Suggested Assessment Methods Practicals
- Laboratory Participation
- Laboratory Report/Manual
- Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Edward Allen, Joseph Iano, (2019), Fundamental of Building Construction Materials and Methods, 7th Edition (or latest), John Wiley & Sons. NY.
2. Eva Kultermann and William P. Spence, Construction, Materials, Methods, and Techniques, Building for a sustainable future (2022), 5th Edition (or latest), Cengage Learning, Inc.
3. William F., Smith, (2009), Foundation of Materials Science & Engineering, 5th Edition (or latest), McGraw Hill.
4. Duggal, S. K, (2010), Building Materials, New Age International.
5. David R. H. Jones and Michael F. Ashby, Engineering Materials 1, An Introduction to Properties, Applications and Design (2019), 5th Edition (or latest), Butterworth-Heinemann publishing.

# ENGINEERING DRAWING

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

## DESCRIPTION

This course will give students a detailed understanding of basic drawing concepts as well as simple architectural and civil engineering drawings. The course will provide detailed guidance on the manual drawing concepts keeping in mind the load bearing masonry structures. Emphasis will be placed on developing the drawing skills of the students.

## COURSE LEARNING OUTCOMES

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

1. EXPLAIN fundamental concepts of engineering drawing for simple objects/structures.
2. Manually DEVELOP drawings of simple objects / load bearing structures.

## COURSE OUTLINE (THEORY)

**1. Introduction to Engineering Drawing and Types of Civil Engineering Drawings**

- Drawing, sketch, painting and map
- Drawing instruments and their use
- Type of drawing lines and appropriate uses
- General rules for drawing lines
- Gothic lettering
- Dimensioning
- Planning of a drawing sheet
- Drawing types with respect to technicality (Survey plan, contour plan, geotechnical plan, infrastructures drawing, architectural drawing, structural drawing, plumbing drawing, electrical drawing, HVAC drawing)
- Drawing types with respect to project execution (Proposals/PC-1 drawing, Submission /Tender drawing, Working /Construction drawing, Completion /As-built drawing.

**2. Conceptual Drawings and Projection system**

- Conceptual drawing
- Projection system and its variables

- Classification of projections
- Perspective and parallel projections
- Oblique projection
- Axonometric projection (isometric projection)
- Orthographic projections (First-angle and third-angle projection) and their comparison
- Importance of line types and rules
- Glass box concept and six principle views
- Comparison between isometric and orthographic views
- Sections, Details behind the cutting plane, Parts not sectioned
- Scaling

**3. Architectural Plan, Elevation and Section of a Simple Building (House)**

- Architectural views (Plan, elevation and section) of a simple building
- General terminologies and symbols including schedule of opening
- Architectural design of a house
- Seismic requirement for architectural design
- General notes

**4. Structural Details of a Simple Building (House)**

- Foundation plan
- Plinth plan
- Lintel plan
- Slab plan
- Cross-sectional details of foundation, columns, vertical stiffeners, plinth band, lintel band, lintels, beams and slabs
- General notes

**5. Architectural and Structural Details of Boundary Wall and Staircase (House)**

- Plan, elevation and section of a boundary wall
- Structural design considerations
- Simple staircase and its components terminology
- Architectural details of a simple stair
- Structural details of a simple stair
- Types of stairs

**6. Structural Details of Water Tank for House**

- Base slab
- Top slab
- Section
- Sump pit detail
- Cover detail
- General notes

**7. Plumbing, sanitation, and Roof Drainage Plan of a Simple Building (House)**

- Typical water supply system
- Water and waste water removal system
- Roof drainage slopes
- Standard Plumbing symbols
- General notes

**8. Electrical and HVAC Drawings of a Simple Buildings (House)**

- Typical layout of electrification
- Symbols used for electrical layout
- Typical layout of HVAC
- Symbols used for HVAC layout
- General notes

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

1. Border line / margin, title box, gothic lettering, isometric views, orthographic views (first and third angles) and sections.
2. Architectural plan, elevation and section of a simple building (house).
3. Structural details of a simple building (house).
4. Architectural and structural details of a boundary wall.
5. Architectural and structural details of stair case in a house.
6. Structural details of a water tank for house.
7. Plumbing, sanitation, and roof drainage plan of a simple building (house).
8. Electrical and HVAC drawings of a simple building (house).

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

- Lecturing
- Laboratory Demonstration
- Guest Speaker
- Field Visits

**Suggested Assessment Methods - Theory**

- One hour test(s)/Mid-term
- Quiz tests, Assignments, Project Reports/ Term Paper/ Presentations with emphasis on PBL/ CEP/ DP/ OEL etc.
- Final Exam

**Suggested Assessment Methods - Practicals**

- Laboratory Participation
- Laboratory Report/Manual (Drawing Volume)
- Laboratory Quiz / Viva Voce / Midterm / Final Term

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Horchsel R. P; Engineering Drawing and Geometry, John Willy & Sons, 2nd Edition, 2002.
2. Jensen C.H and Mason F. H. S "Drafting Fundamentals", McGraw Hill, 5th Edition.
3. N. D. Bhatt; Engineering Drawing, 50th Edition (2010), Charotar Book Stall
4. Parkinson, A. C. A First Year Engineering Drawing. English language Book Society. Reprint 1964.
5. Basics of Engineering Drawing by Dr. Zahid Ahmed Siddiqi, 2016

## ENGINEERING SURVEYING

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

### DESCRIPTION

The main purpose of the course is to enable students to understand theory and practice of land surveying. This course is also aimed to enable students in reading and preparing surveying maps and to develop their skills to use modern survey instruments.

### COURSE LEARNING OUTCOMES

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

1. EXPLAIN basic surveying techniques used for surveying and leveling.
2. PREPARE maps and plans, contour maps, profiles, cross- sections, etc. using surveying techniques.
3. OPERATE various survey equipment for measurements with required accuracy.

### COURSE OUTLINE (THEORY)

**1. Introduction**

- Introduction to land surveying, Definitions of basic surveying terms branches and their application, Instruments used

**2. Survey Techniques**

- Distance measurement techniques, Compass survey, and Theodolite survey

**3. Traversing and triangulation**

- Method of Running Traverses with Theodolite, Traverse computations, Transformation of Co-ordinates, Omitted Measurements, Triangulation, Classification of triangulation systems

**4. Leveling and Contouring**

- Methods and types of levels, precise leveling, Tacheometry and trigonometrical levelling, Methods and applications of contouring

**5. Computations and Plotting**

- Maps and plans, plotting, contour maps, profiles, cross-sections, prismoidal formula, Computation of areas and volumes by various methods, Computations of area and volumes by graphical analysis and use of surveying software

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

1. Introduction to basic surveying instruments
2. Measurement of distances with linear instruments, Chain Surveying and plotting
3. Compass Traversing and plotting
4. Plane Table surveying by radiation and Intersection methods.
5. Two Points Problem, Three Points Problem
6. Introduction to level and Level adjustments by two-peg method
7. Profile leveling
8. Cross-Sectioning and plotting

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

- Lecturing
- Laboratory Demonstration
- Written Assignments
- Guest Speaker
- Field Visits

**Suggested Assessment Methods Theory**

- One hour test(s)/Mid-term
- Quiz tests, Assignments, Project Reports/Term Paper/Presentations
- Final Exam

**Suggested Assessment Methods Practicals**

- In Lab assessment through rubrics
- Post lab assessment through rubrics
- Laboratory Report/Manual
- Final Viva Voce Examination

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Surveying Theory and Practice, R.E. Davis, 7th Edition
2. Wolf P. R. & Ghilani C. D., (2004), Elementary Surveying – An introduction to Geomatics, 11th Edition, Prentice Hall, USA.
3. Thomas, M. Lillesand & Ralph W. Kiefer, (2005), Remote Sensing and Images Interpretation, 5th edition, John Wiley & Sons, Inc.
4. Kavanagh Barry, (2010), Surveying with Construction Applications, 7th Edition, Pearsons Education.
5. Surveying and Leveling by "T.P Kanetkar & S.V. Kulkarni" Part I and II

# MECHANICS OF SOLIDS-I

Credit Hours: 3+1=4
Pre-Requisites: Engineering Mechanics

## DESCRIPTION

This course equips students with fundamental knowledge of strength of materials, enhancing their skills in selecting appropriate materials for Civil Engineering applications. The theoretical component covers topics such as uniaxial stress and strain, relationships between elastic constants, material response under different loading conditions, bending theory, deflections of beams, torsion, and stress and strain transformations. The practical component includes hands-on activities such as assessing the compressive and tensile strength of concrete and determining tensile and shear strength of mild steel bar.

## COURSE LEARNING OUTCOMES

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

1. DISCUSS the behavior of members (bars, beams) subjected to different sets of loading and states of stresses.
2. SOLVE problems related to biaxial state of stresses
3. PRACTICE experiments to study the material response under different sets of loadings

## COURSE OUTLINE (THEORY)

**1. Stress, Strain and Mechanical Properties of Materials**

- Uniaxial state of stress and strain
- Relationships between elastic Constants
- Response of materials under different sets of monotonic loading (including impact)
- Normal and shearing stress and strains
- Distribution of direct stresses on uniform and non-uniform members
- Thermal stresses and strains

**2. Bending Theory**

- Shear Force and Bending Moment Diagrams
- Relationship between load, shear force and bending moment
- Theory of bending
- Moment of resistance and section modulus
- Bending and shearing stress distribution in beams
- Stresses in composite sections

**3. Deflections of Beams**
- Curvature, slope and deflection of beams using integration methods

**4. Theory of Torsion**
- Theory of torsion of solids and hollow circular shafts
- Shearing stress distribution, angle of twist, strength and stiffness of shaft

**5. Stress and Strain Transformations**
- Biaxial state of stresses
- Resolution of stresses
- Principal plane, principal stresses and strains,
- Graphical representation of stress and strains, Mohr's circle of stresses and strains

## COURSE OUTLINE (PRACTICALS)

The following practical exercises may be taken up for the course.

1. Determination of the compressive strength of cement.
2. Determination of tensile strength of cement.
3. Determination of yield strength, ultimate strength, rupture strength and percentage elongation of mild steel bar.
4. To perform the Izod Impact Test for the given metals.
5. Determination of the modulus of elasticity of the material of the given rectangular beam.
6. Determination of the modulus of rigidity of the material of the given specimen with circular cross-section.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**
- Lectures (audio/video aids)
- Written Assignments/ Quizzes
- Tutorials
- Case Studies relevant to engg disciplines
- Semester Project
- Guest Speaker
- Industrial/ Field Visits
- Group discussion
- Report Writing

**Suggested Assessment Methods Theory**
- Mid Term
- Report writing/ Presentation
- Assignments
- Project Report

- Quizzes
- Final Term

**Suggested Assessment Methods Practicals**

- Laboratory Participation
- Laboratory Report/Manual
- Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Pytel, A. & F. L.Singer, Strength of Material, Harper & Row Publishers, New York.
2. Hibbler, R. C., Mechanics of Materials, Prentice Hall, 10th Edition
3. Warnock, F. V., Benham, P. P., Mechanics of Solids and Strength of Materials, Pitman Publishing, 1970.
4. James M. Gere & Barry. J. Goodno, Mechanics of Materials, 7th Edition, 2008, CL Engineering
5. James M. Gere Mechanics of Materials, 8th Edition.

# STRUCTURAL ANALYSIS-I

Credit Hours: 3+0=3
Pre-Requisites: Engineering Mechanics

## DESCRIPTION

This course provides a comprehensive understanding of structural analysis principles and their vital role in the design process. The course commences with an introduction to structural analysis, covering types of structures, structure idealization, and loads. Also, it addresses key concepts like redundancy and stability. Subsequent modules delve into the analysis of determinate pin-jointed structures and rigid jointed plane frames, exploring joint and section analysis, as well as graphical techniques for shear and moment. The curriculum extends to analyzing structures under moving loads, emphasizing influence lines for reactions and member forces. The course further explores three-hinged arches, cables, and suspension bridges, employing techniques like moment area and Castigliano's second theorem. Students develop analytical skills for assessing determinate structural members in static and dynamic conditions.

## COURSE LEARNING OUTCOMES

By the end of this course, students will be able to:
1. DESCRIBE various methods of analysis for determinate structures.
2. APPLY methods of analysis on determinate structures.
3. ANALYZE the beam and girders under the application of moving loads.

## COURSE OUTLINE (THEORY)

**1. Introduction to Structural Analysis**
- Types of structures
- Structure idealization and loads
- Redundancy and stability of structures

**2. Analysis of Determinate Pin-Jointed Structures**
- Methods of joint
- Methods of sections
- Methods of moment and
- Shear graphical method

**3. Analysis of Statically Determinate Rigid Jointed Plane Frames**
- Axial force diagram
- Shear force diagram
- Bending moment diagram

**4. Moving Loads**

- Influence lines for reactions
- Shear force and bending moment in statically determinate beams and paneled girders
- Influence lines for member forces in pin jointed frames
- Calculation of maximum stress function (reaction, shear, bending moment, axial force) in these structures

**5. Three Hinged Arches, Cables and Suspension Bridges**

- Rotation and deflection of beams by moment area
- Method Conjugate beam method
- Castigliano's second theorem
- Rotation and deflection of plane trusses and frames
- Principle of virtual work, unit load method, graphical method

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

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

**Suggested Assessment Methods Theory**

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

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. R. C. Hibbler, Structural Analysis, Prentice Hall, 9th Edition (2016).
2. Wang, C. K., (1984), Intermediate Structural Analysis, McGraw-Hill Education - Europe.
3. K. M. LEET & Chia-Ming Uang, Fundamentals Structural Analysis rentice Hall, 7th Edition, 2009.

4. H. H. West, Fundamentals of Structural Analysis, John Willey-New York, 2nd Edition, 2002.
5. N.J. Alexender Chajes, Structural Analysis, Prentice Hall, 3rd Edition, 1995.W. J. Spencer, Fundamental Structural Analysis, Palgrave MacMillon, 1988 New York, Inc.

# SOIL MECHANICS

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

## DESCRIPTION

This course offers a detailed insight into fundamental engineering concepts of soil behavior, emphasizing its physical and index properties. It covers basic geotechnical properties for soil classification using various systems. It also describes interaction between water and soil, and the in-situ stresses with the impact of static and flowing water. Additionally, the course analysis soil compaction mechanisms, and consolidation process. The course also provides practical methods for quantifying the related parameters.

## COURSE LEARNING OUTCOMES

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

1. EXPLAIN fundamental engineering concepts of soil's behavior based on its physical and index properties, and classification of soil.
2. DESCRIBE interaction between water and soil and the effects of static versus flowing water on soil's behavior, and in-situ stresses.
3. ANALYZE compaction and its mechanism, and process of consolidation in soils.
4. PRACTICE laboratory testing to determine index properties of soil, flow of water through soil, and compaction and consolidation parameters of soil

## COURSE OUTLINE (THEORY)

**1. Introduction**

- Introduction to soil mechanics and geotechnical engineering
- Significance of geotechnical engineering
- Soil formation, transportation, sorting, and deposition
- Types of soil deposits and their properties
- Soil types, soil structure and clay minerals.

**2. Index and Physical Properties**

- Basic physical and index properties of soil
- Water content, void ratio, porosity, degree of saturation, air voids, unit weights, specific gravity etc.
- Phase relationships, and numerical examples
- Particle size and shapes, sieve Analysis, hydrometer Analysis.
- Consistency and various states of fine-grained soils

- Atterberg's limits
- Related numerical examples

**3. Soil Classification Systems**

- Importance of soil classification
- Grain size distribution, gradation curves and interpretation
- Soil classification systems: Textural classification system, AASHTO soil classification system, Unified soil classification system, and description of their subgroups.
- Related numerical examples.

**4. Permeability and Seepage**

- Permeability and Seepage
- Darcy's law
- Factors affecting permeability.
- Laboratory and filed determination of permeability.
- Capillary action and its effects in soils
- Seepage force
- Introduction to flow net
- Quicksand condition and sand boiling
- Related numerical examples.

**5. In-Situ Stresses**

- Stress condition in soil: effective and neutral stresses, stresses in saturated soils with upward and downward seepages

**6. Compaction of Soils**

- Compaction of soils
- Fundamentals of compaction
- Standard and modified Proctor compaction tests
- Moisture density relationship
- Compaction standards
- Factor effecting compaction.
- Field control and measurement of in situ density and field compaction.
- Numerical examples and assignments.

**7. Consolidation of Soils**

- Consolidation of soils
- Mechanics of consolidation
- Theory of one-dimensional consolidation, related assumptions, and validity
- Oedometer test and graphical representation of data
- Compression index and co-efficient of compressibility
- Time factor, coefficient of volume change and degree of consolidation
- Primary and secondary consolidation

- Normal and pre-consolidated soils
- Related numerical examples.

## COURSE OUTLINE (PRACTICALS)

The following practical may be carried out for the course.

1. To determine moisture content of soil in laboratory
2. To determine specific gravity of fine-grained soils in the laboratory
3. To determine particle size distribution of soils using sieve and hydrometer analyses.
4. To determine Atterberg's consistency limits of soils
5. To determine laboratory compaction characteristics of soils using standard and modified Proctor compaction test procedures
6. To determine in-place/in-situ/field density of soils
7. To determine permeability of soils using standard constant head and falling head permeability tests
8. To determine consolidation characteristics of soils using oedometer test apparatus

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theory**

One hour test(s)/Mid-term
Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Final Exam

**Suggested Assessment Methods Practical**

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Braja M. Das (2020), Principles of Geotechnical Engineering, 10th Ed, Cengage Learning, Inc. USA.
2. Braja M. Das, (2020), Advanced Soil Mechanics, 5th Ed, CRC Press, 734 pp.
3. Craig, R. F. (2019). Craig's Soil Mechanics, 9th Ed., CRC Press, 654 pp.

4. Holtz and Kovac (2012), An Introduction to Geotechnical Engineering, Latest Edition, Prentice Hall.
5. Doland P. Coduto (1999/Latest Edition), Geotechnical Engineering-Principles and Practices, Prentice-Hall, Upper Saddle River, NJ 07 458.
6. Bowles J. E. (1984). Physical and Geotechnical properties of Soils, 2nd Ed., McGraw-Hill, New York, 578 pp.

# FLUID MECHANICS

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

## DESCRIPTION

This course will enable students to learn basics of fluid mechanics for civil engineering applications including properties of fluids, fluid statics, forces on immersed bodies, fluid kinematics, hydrodynamics, flow measuring devices in pipes and open channels. An introduction will be given to the basic principles of fluid mechanics in stationary fluids and in motion.
The course will provide detailed guidance on enable students to perform various experiments in Fluid Mechanics laboratory.

## COURSE LEARNING OUTCOMES

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

1. DESCRIBE the physical properties of fluids.
2. COMPUTE pressure and center of pressure on submerged surfaces and the stability of floating and submerged bodies.
3. ANALYZE pipe flow problems using continuity and energy equations.
4. COMPUTE discharge in open channels having uniform flow and pressure in pipes using their measurement devices.
5. DESCRIBE theory and results of experiments related to Fluid Mechanics.

## COURSE OUTLINE (THEORY)

**1. Introduction**

- Solids and fluids (liquids and gases) Units and dimensions
- Physical properties of fluids; density, specific weight, specific volume, specific gravity, surface tension, compressibility
- Viscosity and its measurement Newton's equation of viscosity, Hydrostatics
- Kinematics Hydrodynamics Hydraulics

**2. Fluid Statics**

- Pressure intensity and pressure head, Pressure and specific weight relationship, Absolute and gauge pressure Measurement of pressure
- Piezometer, manometer, Pressure transducers
- Differential manometer and Borden gauge

**3. Forces on Immersed Bodies**
- Forces on submerged planes & curved surfaces and their applications
- Buoyancy and floatation
- Equilibrium of floating and submerged bodies

**4. Fluid Kinematics**
- Steady and unsteady flow
- Laminar and turbulent flow
- Uniform and non-uniform flow
- Path lines, streamlines and stream tubes
- Velocity and discharge
- Control volume
- Equation of continuity for compressible and incompressible fluids

**5. Hydrodynamics**
- Different forms of energy in a flowing liquid
- Bernoulli's equation and its application
- Energy line and Hydraulic Gradient Line
- Introduction to density currents, free and forced vortex
- Forces on pressure conduits, Reducers and bends
- Forces on stationary and moving plates / blades
- Torques in rotating machines

**6. Flow Measurement**
- Orifices and mouthpieces, sharp-crested weirs and notches, Pitot tube and pitot static tube
- Venturimeter, orificemeter

**7. Steady Flow through Pipes**
- Darcy-Weisbach equation for head losses in pipe lines
- Hydraulic grade lines and energy lines
- Pipes in series and parallel
- Transmission of energy through pipes
- Introduction to computer aided analysis of pipe networks

**8. Uniform Flow in Open Channels**
- Chezy's and Manning's equations, Bazin's and Kutter's equations
- Most economical rectangular and trapezoidal sections

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.
- To prepare layout plan of Fluid Mechanics Laboratory.
- To measure the physical properties of a liquid (oil).
- To determine the meta-centric height of a floating body (model of a ship) and to locate position of center of buoyancy, metacenter and center of gravity.
- To measure the hydrostatic force of a submerged body and to locate its

centre of pressure.

- To verify the Bernoulli's theorem in the laboratory.
- To determine the coefficient of discharge for a Venturi meter.
- To determine the coefficient of discharge for Rectangular and V-Notches.
- To determine the hydraulic coefficients for various types of orifices.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theory**

One hour test(s)/Mid-term
Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Final Exam

**Suggested Assessment Methods Practicals**

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Daugherty, R. L., J. B. Franzini and Fenimore, Fluid Mechanics with Engineering Application, McGraw-Hill New York (Latest Edition)
2. Monson Young, Fundamentals of Fluid Mechanics, (Latest Edition)
3. Douglus, Fluid Mechanics, McGraw-Hill Inc.
4. Jack P. Fundamentals of Fluid Mechanics, McGraw-Hill Inc.
5. Merle Potter, Mechanics of Fluid, CL- Engineering (2011)

# ENGINEERING MECHANICS

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

## DESCRIPTION

This course is setup to introduce students with basic concepts of Engineering mechanics based on equilibrium, principles and application of forces, calculation of resultants, geometrical properties related to different shapes and their application in Civil Engineering. Further to this an introduction to simple dynamics is given to the students

## COURSE LEARNING OUTCOMES

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

1 Understand concepts of engineering mechanics
2 Application of engineering mechanics to civil engineering problems
3 Practice the concepts of engineering mechanics

## COURSE OUTLINE (THEORY)

**Course Contents:**

**1. Basic Concepts**

- Concepts of space, time, mass, velocity, acceleration and force
- Scalar and vector quantities
- Newton's law of motion
- Law of gravitation

**2. System of Forces**

- Resultant and resolution of co-planer forces using parallelogram, triangle &
- Polygon law and funicular polygon
- Simple cases of resultant and resolution of forces in space
- Conditions of equilibrium of co-planar forces, analytical and graphical
- Formulations

**3. Equilibrium of Rigid Bodies**

- Free body concept, conditions of support and attachment to other bodies
- Support reactions under different types of loading
- Introduction to shear force and bending moment diagrams
- Degree of restraint and static determinacy
- Statically determinate problems especially of civil engineering importance,
- Equilibrium of two-force and three-force bodies

**4. Kinematics**

- Work, energy and power
- Virtual work formulation of equilibrium of coplanar force
- Potential energy, energy criterion for equilibrium, stability of equilibrium,
- application to simple cases

**5. Rigid Bodies**

- Geometrical properties of plane areas
- First moment of area, centroid, second moment of area, principal axes, polar
- Second moment of area and radius of gyration

**6. Friction**

- Coulomb's theory of friction
- Problems involving friction on flat and curved surfaces

**7. Application of Principles of Dynamics**

- Rectilinear and curvilinear motion
- Newton's equation of motion, dynamic equilibrium
- Introduction to practical use of the above principles and properties.

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

- To determine the surface area and volume of steel cabinet and woodencube in CGS, MKS, FPS and SI system of units.
- To determine center of gravity (centroid) of various objects by analytical solution.
  and experimental Observations.
- To verify the principle of moments.
- To measure centrifugal force.
- To measure moment of inertia of disc moving down the inclined plane.
- To determine the reaction of a simply supported beam by Experimental Observation (using spring balances), Analytical Solution (using condition of equilibrium) and Graphical Solution (using Funicular Polygon).
- To find the forces in the tie and jib of a jib crane.
- To verify the laws of friction between various surfaces and to find out the coefficient of friction.
- To determine the tension in various points of a hanging rope loaded at different points.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

- Lectures (audio/video aids),
- Written assignments/Quizzes,
- Tutorials,
- Case Studies relevant to Engg. disciplines,
- Semester project,
- Guest speaker,
- Industrial/Field visits,
- Group discussion,
- Report Writing.

**Suggested Assessment Methods Theory**

- Mid-term exam,
- Report writing/ Presentation,
- Assignment,
- Project report,
- Quizzes,
- Final term exam/ assessment.

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. S. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest Edition).
2. R E Thomas, A J Rosa and G J Toussaint, "The Analysis and Design of Linear Circuits" John Wiley, 6th Edition, 2009
3. C Alexander and M Sadiku, "Fundamentals of Electric Circuits", McGraw-Hill, 4th Edition, 2008
4. J D Irwin and R M Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008
5. W Hayt, J Kemmerly and S Durbin, "Engineering Circuit Analysis", McGraw- Hill, 7th Edition, 2007.

## ADVANCED ENGINEERING SURVEYING

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

### DESCRIPTION

The course objective is to acquire knowledge of control surveys and their use in advanced branches of surveying. The course will enable the students to apply principles of surveying and modern tools in related field problems.

### COURSE LEARNING OUTCOMES

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

1. CALCULATE various types of curves
2. CARRY OUT construction, control hydrographic surveys, field astronomy, photogrammetry and GPS surveys
3. COMMIT to individual or group survey task as a leader or member expressing team spirit and inspiring Conduct

### COURSE OUTLINE (THEORY)

**1. Highway and Railway Curves**

- Circular curves, deflections and chord calculations, Setting out circular curves by various methods, Compound curves, reverse, vertical, parabolic curves, Computation of high or low point on a vertical curve, Design considerations, spiral curves, spiral curve computations, Approximate solution for spiral problems, super elevations

**2. Construction Surveys**

- Introduction, horizontal and vertical control, Buildings, rail roads, Route surveys, Pipeline and other construction surveys

**3. Control Surveys**

- Geodesy universal transverse Mercator grid system, Modified transverse Mercator grid system, Lambert projection, Computations for lambert projection

**4. Hydrographic Surveys**

- Objectives of hydrographic survey and electronic charting, Vertical control, depth and tidal measurements, Position fixing techniques, Sounding plan, horizontal control

**5. Field Astronomy**

- Solar and stellar observations for position and azimuth determination

**6. Photogrammetry**

- Introduction, Application of aerial and terrestrial photogrammetry, Stereoscopy

**7. Tunnel Surveying**

- Introduction, Surface Alignment, Setting out from Ends, Transferring Alignment Underground, Use of gyroscope

## COURSE OUTLINE (PRACTICALS)

1. Study and Use of advanced surveying equipment, Theodolite Traversing, Contouring
2. Simple Curve. Compound Curve, Transition Curve, Operation of Total Station, Operation of GPS.
3. Advance surveying instruments
4. Theodolite instruments
5. Setting out a Simple curve
6. Setting out a Compound curve
7. Setting out a Transition curve
8. Total station
9. Electronic distance measurement (EDM)
10. GPS

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

- Lecturing
- Laboratory Demonstration
- Written Assignments
- Guest Speaker
- Field Visits

**Suggested Assessment Methods Theory**

- One hour test(s)/Mid-term
- Quiz tests, Assignments, Project Reports/Term Paper/Presentations
- Final Exam

**Suggested Assessment Methods Practicals**

- In Lab assessment through rubrics
- Post lab assessment through rubrics
- Laboratory Report/Manual
- Final Viva Voce Examination

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Surveying Theory and Practice, R.E. Davis, 7th Edition
2. Wolf P. R. & Ghilani C. D., (2004), Elementary Surveying – An introduction to Geomatics, 11th Edition, Prentice Hall, USA.
3. Thomas, M. Lillesand & Ralph W. Kiefer, (2005), Remote Sensing and Images Interpretation, 5th edition, John Wiley & Sons, Inc.
4. Kavanagh Barry, (2010), Surveying with Construction Applications, 7th Edition, Pearsons Education.
5. Surveying and Leveling by "T.P Kanetkar & S.V. Kulkarni" Part I and II

# ADVANCED FLUID MECHANICS

Credit Hours: 2+1=3
Pre-Requisites: Fluid Mechanics

## DESCRIPTION

This course will give students a detailed understanding of basic fluid mechanics principles, differential form of continuity equation, flow nets, solution of pipe flow problems in laminar and turbulent flow, analysis of dynamics forces acting on fully immersed bodies in the fluids, impulse momentum principle and its applications. The course will provide detailed guidance on hydraulic working of various types of turbines and pumps. Students will be able to use a software to design the turbines.

## COURSE LEARNING OUTCOMES

By the end of this course, students will be able to:
1. Analyze the pipe flow problems to formulate solutions based on laminar and turbulent flow regimes.
2. Analyze the working of hydraulic machines for an effective design of water supply and hydropower schemes.
3. Solve open channel flow problems by using uniform flow equations.
4. Demonstrate basic principles of fluid mechanics by carrying out experiments.

## COURSE OUTLINE (THEORY)

**1. Hydrodynamics Review**
- Ideal and real fluids
- Differential equation of continuity
- Rotational and irrational flow
- Stream function and velocity potential function
- Brief description of flow fields
- Orthogonality of stream lines and equipotential lines
- Flow net and its limitations
- Different methods of drawing flow net.

**2. Steady Flow through Pipes**
- Laminar and turbulent flow in circular pipes, semi empirical theories of turbulence
- General equation for friction
- Velocity profile in circular pipes, pipe roughness

- Nukuradse's experiments
- Darcy-Weisbach Equation
- Friction Factor and Moody's diagrams
- Pipe flow problems
- Minor losses
- Branching pipes

**3. Flow around immersed bodies**

- Lift and drag force
- Boundary layer along smooth flat plate
- Thickness of boundary layer, shear stresses and velocity distributions
- Types of boundary layers (laminar, turbulent and laminar and turbulent)
- Friction drag coefficient

**4. Impact of Jets**

- Impulse momentum principle
- Force of jet on stationary flat and curved plates
- Force of jet on moving flat and curved plates
- Forces on plumbing fittings

**5. Water Turbines**

- Types of turbines
- Impulse and reaction turbines
- Momentum equation applied to turbines
- Specific speed
- Turbine characteristic curves
- cavitation and operation

**6. Centrifugal Pumps**

- Types
- Classifications
- Construction features, operation and efficiencies
- Maximum suction lift
- Specific speed and characteristic curves

**7. Reciprocating Pumps**

- Types
- Construction features
- Single acting and Double acting Reciprocating pumps
- Coefficient of discharge and slip of the pump
- Sum of heads in single acting reciprocating pumps

**8. Introduction to related software**

- Trbnpro software application

## COURSE OUTLINE (PRACTICALS)

1. To measure the head loss in a pipe of uniform diameter and to investigate the critical Reynolds Number, relationship between hydraulic gradient and velocity of flow and relationship between friction factor and Reynolds Number.
2. To verify the 'Impulse Momentum Principle' for a jet of water striking on 90o, 120o & 180o deflectors and to investigate the effect of velocity of flow on impulse force of the jet for various deflectors.
3. To make the study of the 'Pelton Wheel' and 'Turgo Impulse Turbine.
4. To perform experiment on Pelton Wheel and hence to plot its characteristic curves.
5. To make the study of Francis Reaction Turbine.
6. To make the study of Double Stage Centrifugal Pump.
7. To perform experiment on "Double Stage Centrifugal Pump" and hence to plot its Characteristic Curves.
8. To perform experiment on the "Double Acting Reciprocal Pump" and to determine co-efficient of discharge and Slip of the Pump.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

- Lecturing
- Laboratory Demonstration
- Written Assignments
- Guest Speaker
- Field Visits

**Suggested Assessment Methods Theorey**

- One hour test(s)/Mid-term
- Quiz tests, Assignments, Project Reports/Term Paper/Presentations
- Final Exam

**Suggested Assessment Methods Practicals**

- Laboratory Participation
- Laboratory Report/Manual
- Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Daugherty, R. L. Franzini B. & Finnemore E. J., Fluid Mechanics, McGraw Hill Book Co. (Latest Edition)
2. Douglus, Fluid Mechanics, McGraw-Hill Inc. (Latest Edition)
3. Jack P., Fundamentals of Fluid Mechanics , McGraw-Hill Inc. (Latest Edition)
4. Merle Potter, Mechanics of Fluid, CL- Engineering (2011)

# REINFORCED CONCRETE DESIGN-I

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

## DESCRIPTION

The purpose of this course is to provide students with a thorough understanding of the design of reinforced concrete buildings/structures with particular emphasis on using the locally available steel rebars and concrete. Topics covered will include: Properties, Application and Testing of Plain Concrete, Basic Principles for Reinforced Concrete design, design of beams and slabs for flexure and shear; detailing of flexural and shear reinforcement; behaviour of reinforced concrete members under combined flexure and axial load; design of short columns; as well as detailing of steel for bond & development length and laps & splices, with focus on local practices.

## COURSE LEARNING OUTCOMES

By the end of this course, students will be able to:
1. ILLUSTRATE various properties of concrete.
2. DESIGN various structural reinforced concrete elements.
3. PRACTICE experiments on concrete for suitable use.

## COURSE OUTLINE (THEORY)

**1. Plain Concrete (Properties, Application and Testing)**
- Concrete constituent material and its mechanical properties
- Properties of freshly mixed concrete
- Durability aspects and factors contributing towards durability
- Creep and shrinkage of concrete
- Mix design and quality control
- Additives and admixtures
- Air entrainment
- Lightweight concrete
- Hot and cold weather concrete
- Precast concrete with special reference to cement concrete blocks
- Determination of fundamental structural properties of concrete and non-destructive testing (NDT)

**2. Reinforced Concrete (Basic Principles, Working Stress and Ultimate Strength Method)**
- Basic principles of reinforced concrete design and associated assumptions

behavior of reinforced concrete members in flexure, design philosophy, design codes, factor of safety and load factors, prevailing methods of design of reinforced concrete members.

- Working stress method, serviceability criteria and checks for deflection, crack width, and crack spacing, Importance of working stress method related to pre-stress.
- Ultimate strength method, analysis of prismatic and non-prismatic sections in flexure, compatibility-based analysis of sections and code requirements for flexure

**3. Structural Framing and Load Calculations of a Simple Structure for Gravity Design**

- Structural framing
- Load calculations, types of basic loads, service and factored load combinations
- Load distribution and calculations for slabs, beams, columns and footings

**4. Slab Analysis and Design for Gravity Loading**

- One-way solid and ribbed slabs
- Two-way solid slabs using coefficient method
- General discussion on other slab systems
- Design detailing

**5. Beam Analysis and Design for Gravity Loading**

- Flexure analysis and design of beams (singly, doubly, rectangle section, T/L sections, simple span, one end and both end continuous)
- Shear analysis and design of beams
- Design detailing

**6. Columns**

- Analysis of sections in pure compression,
- Design of short columns under pure compression and with eccentric loading,
- Design detailing
- Footings
- Isolated footings
- Structural design of simple rectangular footing and combined footing.
- Design detailing

**7. Steel Detailing (Bond, Anchorage & Development Length)**

- Design and detailing for bond, anchorage, development length, laps and splices

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

- To study the compressive strength of concrete using cube and cylinder.
- To prepare mix design for various strengths of concrete.
- To find workability of concrete using slump cone method, compacting factor method, VeBe time method.
- To study the effect of w/c ratio on the strength of concrete.
- To study effect of aggregate/cement ratio of workability and compressive strength of concrete.
- To determine the strength of concrete using core extraction and to discuss the results from control cylindrical samples.
- To study the ultrasonic pulse velocity test and Schmidt hammer test on hardened concrete.
- To study the behaviour of balanced reinforced, under-reinforced and over-reinforced concrete flexural members.
- To study the behaviour of shear deficient flexural members.
- To study the permeability of concrete samples with various mix ratio.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theorey**

One hour test(s)/Mid-semester Exam (s)
Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Final Exam

**Suggested Assessment Methods Practicals**

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. David Darwin, Charles Dolan, Arthur Nilson, (2016) Design of Concrete Structures. 15th (or latest) Edition., McGraw-Hill.
2. James K Wight and James G. Macgregor, Reinforced design: Mechanics and design, (2011), 6th (or latest) Edition.

3. M. Neville, (2011), Properties of Concrete, 5th edition, John Wiley.
4. Hassoun, M. N. & Al-Manaseer, A, (2015), Structural Concrete: Theory and Design, 7th (or latest) Edition.
5. Chu-Kia Wang, Charles G. Salmon, José A. Pincheira, (2017), Reinforced Concrete Design, Wiley; 8th (or latest) Edition.
6. N.V.Nayak & A.K.Jain, Handbook on Advanced Concrete Technology.
7. Concrete Structures, Part-I, 3rd (or latest) Edition, by Zahid Ahmed Siddiqi, 2016.

# ENVIRONMENTAL ENGINEERING

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

## DESCRIPTION

This course will introduce the concept of environmental pollution, contamination and its sources particularly in context to water. The course will elaborate principles of water treatment applied to the design and implementation of water supply schemes.

## COURSE LEARNING OUTCOMES

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

1. EXPLAIN various concepts of water treatment and wastewater treatment
2. APPLY appropriate processes for water pollution control
3. ANALYZE physical and chemical unit operations of water treatment

## COURSE OUTLINE (THEORY)

**1. Introduction**

- Water Engineering
- Sanitary Engineering

**2. Water Pollution**

- Water chemistry and water quality characteristics
- Introduction to sources of pollution
- Effects on water quality
- Control parameters

**3. Water Demand and Supply**

- Population forecast
- Water uses & consumption
- Types and variations in demand
- Maximum demand

**4. Water Quality**

- Water impurities & their health significance
- Water quality guidelines/standards (US-EPA, WHO and NSDWQ Pakistan)
- Water quality monitoring

**5. Water Sampling and Testing**

- Sampling techniques and examination of water (physical, chemical and microbiological parameters)

- Water borne diseases

**6. Water Treatment**

- Treatment of surface & ground water
- Screening (Course and Fine Screens)
- Coagulation and Flocculation
- Sedimentation
- Filtration
- Design aspects of slow sand and rapid sand filters and their operations
- Pressure filters
- Membrane Technology (Reverse Osmosis, Nanofiltration, Ultrafiltration, Microfiltration)

**7. Miscellaneous Water Treatment Techniques**

- Fluoridation, Iron & Manganese removal
- Water softening methods
- Water disinfection and chemicals (Chlorination, Ozonation, Ultraviolet disinfection methods)
- Emergency treatment methods

**8. Water Distribution**

- Layout and design of water transmission works and distribution networks (Hardy Cross and Equivalent Pipe method)
- Service reservoirs
- Fixtures and their installation
- Tapping of water mains
- Urban and Rural Water Supply

**9. Introduction to building drainage.**

**10. Introduction to EIA.**

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

1. Jar test for optimal coagulant dosage
2. Analysis of pH, conductivity, and total dissolved solids (TDS)
3. Analysis of turbidity and total suspended solids (TSS) of surface water samples
4. Analysis of Hardness as $CaCO_3$
5. Analysis of Residual Chlorine
6. Analysis of Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) in wastewater

7. Investigate nitrogenous compounds in wastewater (Ammonium-nitrogen, nitrates, nitrites) in wastewater
8. Investigate phosphate concentrations in wastewater (Total Phosphorus, Phosphate-Phosphorus in wastewater

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theorey**

One hour test(s)/Mid-term
Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Final Exam

**Suggested Assessment Methods Practicals**

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Mark J. Hammer, Jr. Viessman, Elizabath M. Perez, Paul A. Chadik "Water Supply and Pollution Control" (8th Edition, 2015)
2. Sajjad Haider Sheikh, Javed A. Azeez "Water Supply and Sewerage (Theory & Applications)" (1st Edition, 2022)
3. Tom D. Reynolds and Paul A. Richards "Unit Operations and Processes in Environmental Engineering" (Second Edition, 1996)
4. John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe, George Tchobanoglous "MWH's Water Treatment: Principles and Design" Third Edition, 2012)

## STRUCTURAL ANALYSIS-II

Credit Hours: 3+0=3
Pre-Requisites: Structural Analysis-I

### DESCRIPTION

This course delves into the analysis of indeterminate structures under static and dynamic loads. Students will grasp classical methods, become familiar with various techniques, and develop proficiency in state-of-the-art structural analysis approaches. The theoretical framework covers force and displacement approaches, including compatibility methods, moment distribution, and slope deflection for beams and frames. Matrix methods are introduced, encompassing flexibility and stiffness approaches. The course also explores the fundamental concepts of finite element methods with indepth examples. Students who complete this course will have the analytical abilities necessary for indeterminate structural analysis.

### COURSE LEARNING OUTCOMES

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

1. ANALYZE Indeterminate structures using force and displacement methods
2. ANALYZE Indeterminate structures using matrix methods

### COURSE OUTLINE (THEORY)

1. **Analysis of Indeterminate Structures Using Force Approach**
- Compatibility methods for beams and frames with and without support settlement

2. **Analysis of Indeterminate Structures Using Displacement Approach**
- Moment distribution for beams and frames for prismatic and non-prismatic members with and without side-sway and support settlement
- Slope deflection method for beams and frames with and without support settlement

3. **Matrix Methods**
- Introduction to flexibility method
- Introduction to stiffness method
- Development of member and structure stiffness matrices
- Bending moment and shear force diagrams
- Use of appropriate software for matrix operations

4. **Finite Element Method**
- Introduction to finite elements

- Shape functions for bar element
- Three Hinged Arches
- Cables and Suspension Bridges

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lectures (audio/video aids)

Written Assignments/ Quizzes

Tutorials

Case Studies relevant to engg disciplines

Semester Project

Guest Speaker

Industrial/ Field Visits

Group discussion

Report Writing

**Suggested Assessment Methods Theory**

Mid Term

Report writing/ Presentation

Assignments

Project Report

Quizzes

Final Term

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. R. C. Hibbler, Structural Analysis, Prentice Hall, 10th Edition (2021).
2. Aslam Kassimali, (2014), Structural Analysis, 5th Edition
3. Wang, C. K., (1984), Intermediate Structural Analysis, McGraw-Hill Education - Europe.
4. West, H. H., (1989), Analysis of Structures: An Integration of Classical and Modern Methods , John Wiley and Sons Ltd; 2nd Edition.
5. Alexander, Chajes, (1990), Structural Analysis 6. Rizwan, S.A., (2003), Theory of Indeterminate Structures, 2nd Ed.

# QUANTITY & COST ESTIMATION

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

## DESCRIPTION

This course comprises of estimating quantities and cost of various activities in a typical construction project. The students will be exposed to necessary skills of taking quantities off the engineering drawings for preparing the cost estimates.

## COURSE LEARNING OUTCOMES

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

1. Comprehend the quantity take-offs, estimates, their types and procedural requirements.
2. Prepare cost estimates by studying and scrutinizing quantities of various construction activities.
3. Comprehend terms related to tender and contract documents

## COURSE OUTLINE (THEORY)

**1. Quantity Takeoff**

- Review of basic take-off mathematics and measurement Units.
- Takeoff Rules and Measurement Accuracy
- Organization of take-off
- Quantity take-off and Pricing of Labor, Material and Equipment for; Sitework, Concrete, Masonry, Carpentry, and Finishes Works.
- Estimating Procedures and Considerations for Concrete Retaining Wall, Piles, Steel Truss, Road, Sewer and Water Mains Pipe Works.
- Maintaining of Measurement Books

**2. Development of Estimates, Pricing and Related Aspects**

- Types and methods of estimates (conceptual estimates, preliminary, detailed estimates)
- Rate analysis
- Labor productivity
- Cost analysis of construction materials
- Estimate Setup, Overhead, Profit, Sources of Estimating Errors, Escalation, Contingency, Life-Cycle Costing and Analysis.
- Concept of Cost Code
- Use of different types of indices for conceptual estimates

**3. Contractual Aspects Related to Bidding**

- Specifications and their types for various items of construction projects
- Overview of payment schemes in construction projects
- Preparation of Civil Engineering tender/bid proposal documents evaluation methods of proposals and bids.
- Preparation of documents for bid submissions
- Overview of Standard form of contract/bidding documents with special reference to clauses related to cost related issues of the projects (such as PEC, FIDIC, AIA etc.) General practice in government departments for schedule of rates and specifications.

## COURSE OUTLINE (PRACTICALS)

- Introduction (Cost estimating process, Design process and Types of cost estimates). Budget Estimates (Budget estimates, Design budget estimates and Budget estimate accuracy).
- Resources price survey report (prices of all construction materials, equipment and manpower along with their types and availability in local market). Tender notice (Construction / consultancy work)
- Summary of PPRA document.
- Quantity estimation of single room house using long wall method and centerline method.
- Quantity estimation of one story residential building using long wall method and centerline method.
- Quantity estimation of earthwork (excavation for foundation and underground structures).
- Quantity estimation of a RCC Building (RCC column, beam, slab).
- Quantity estimation of a water tank, septic tank, staircase and retaining wall.
- Quantity estimation of pavement of a typical road network.
- Quantity estimation of sewer and pipeline system.
- Rate Analysis and preparation of BOQs.
- Software and spread sheets. Introduction to Autodesk Navis works

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lectures (audio/video aids),

Written Assignments/ Quizzes,
Tutorials,
Case Studies relevant to engg disciplines,
Semester Project,
Guest Speaker,
Industrial/ Field Visits,
Group discussion,
Report Writing

**Suggested Assessment Methods Theory**

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

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Marks Kalin, Robert S. Weygant, Harold J. Rosen & John R. Regenar, Construction Specifications Writing: Principles and Procedures (2010), Wiley.
2. Steven J. Peterson and Frank R. Dagostino, Estimating in Building Construction (2015) 8th Edition, Pearson Publishing.
3. Steven J. Peterson, Construction Estimating Using Excel (2017) 3rd edition Pearson publishing.
4. Standard Form of Bidding Documents by Pakistan Engineering Council.
5. David Chappell, Construction Contracts Questions and Answers (2021), 4th Edition, Taylor & Francis. Jimmie Hinze, Construction Contracts (2010), 3rd Edition, McGraw-Hil

**ENGINEERING HYDROLOGY**

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

## DESCRIPTION

This course will provide an understanding of complexity of movement and distribution of water on the earth, while emphasizing an application to engineering practices. It covers engineering applications of principles of hydrology, including fundamentals of hydrologic cycle, to quantify evaporation and infiltration processes, rainfall and runoff, hydrographs, stream flow routing and groundwater. The focus will be to determines the water balance for a particular region and provides guidance for undergoing proper planning and management of water resources.

## COURSE LEARNING OUTCOMES

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

1. EXPLAIN the basic principles of hydrology, flood routing and groundwater hydrology.
2. ANALYZE various hydrological parameters for surface and groundwater flow.

## COURSE OUTLINE

**1. Introduction**

- Hydrology
- Hydrologic Cycle and the Water Balance Equation
- Practical uses of Hydrology
- Importance of Hydrology

**2. Meteorology**

- The Atmosphere and its Components
- Relative Humidity, Dew Point and Saturation Deficit
- Solar Radiation, Lapse Rate and Adiabatic Changes
- Measurement of Air Temperature, Relative Humidity, Radiation, Sunshine, Atmospheric
- Pressure and Wind Velocity with Direction

**3. Precipitation**

- Types of Precipitation
- Factors Necessary for the Formation of Precipitation
- Measurement of Precipitation

- Interpretation of Precipitation Data
- Computation of Average Rainfall over a Basin

**4. Evaporation and Transpiration**

- Factors Affecting Evaporation
- Measurement of Evaporation
- Evapotranspiration

**5. Stream Flow**

- Water Stage and its Measurement
- Selection of Site for Stage Recorder
- Selection of Control and Metering Section
- Methods of Measurement of Stream Flow
- Interpretation of Stream Flow Data

**6. Runoff & Hydrograph**

- Factors Affecting Runoff
- Estimating the Volume of Storm Runoff
- Characteristic of Hydrograph
- Components of a Hydrograph
- Hydrograph Separation
- Estimating the Volume of Direct Runoff
- Introduction to unit Hydrograph Concept
- S-Curve Preparation
- Application of Probability in Determining Maxima/Minima of Discharge
- Types of Histogram and Distribution

**7. Stream Flow Routing**

- Introduction to Floods and its Causes
- Frequency and Duration Analysis
- Reservoir Routing
- Channel Routing
- Flood Control
- Introduction to Hydrological Modeling

**8. Ground Water**

- Introduction
- Sources and Discharge of Ground Water
- Water Table and Artesian Aquifer
- Aquifer characterization
- Pumping Test
- Tube Well Technology

**9. Water Resources Management**

- Purpose of Water Resources Planning and Management

- Principles of Water Resources Management

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

1. To measure daily evaporation using evaporation pan.
2. To measure daily minimum and maximum temperature.
3. To measure wind speed and direction using anemometer and wind vanes.
4. To measure relative humidity.
5. To measure rainfall depth of a storm event using non-automatic rain gauge
6. To obtain rainfall hyetograph of a storm event using an automatic rain gauge.
7. To study the rainfall-runoff characteristics of a long duration single storm rainfall along with multiple storm rainfalls.
8. To study the effects of reservoir storage on runoff hydrograph.
9. To study the rainfall-runoff characteristics of an urban catchment.
10. To draw a drawdown curve for a single well in an unconfined aquifer pumping at a constant discharge.
11. To draw a drawdown curve for a single well in a confined aquifer pumping at a constant discharge.
12. To observe drawdown at the observation wells using water level indicator while investigating the pumping test of a tube well
13. To measure cone of depression for a single well in hydrology and rainfall apparatus.
14. To study the water abstraction from a well in a confined aquifer.
15. To estimate transmissivity and storativity of confined aquifer using Theis curve method

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing

Laboratory Demonstration

Written Assignments

Guest Speaker

Field Visits

**Suggested Assessment Methods Theorey**

Quiz tests, Assignments, Project Reports/Term Paper/Presentations

Mid-term

Final Exam

**Suggested Assessment Methods Practicals**

Laboratory Participation

Laboratory Report/Manual

Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Subramanya, K., (2020), Engineering Hydrology, 5th Edition, McGraw Hill.
2. Eslamian S., (2014), Handbook of Engineering Hydrology (Fundamentals and Applications), CRC Press
3. Viessman, W., and Lewis, J. L., (2002) Introduction to Hydrology, 5th Edition, Pearson Hall.
4. David, A. Chin, (2010) Water Resources Engineering, 2nd Edition, John Wiley & Sons.

# REINFORCED CONCRETE DESIGN-II

Credit Hours: 3+1 = 4
Pre-Requisites: Reinforced Concrete Design-I

## DESCRIPTION

The purpose of this course is to provide students with a thorough understanding of the design of reinforced concrete structures. The course will enable students to design various reinforced and pre-stressed structural elements using conventional and advanced design approaches. Topics covered will include: design of various types of slabs, design for torsion, slender columns, prestressed concrete design, introduction to earthquake design of reinforced concrete structures, and computer aided design of structures

## COURSE LEARNING OUTCOMES

By the end of this course, students will be able to:
1. DESIGN various structural reinforced concrete elements.
2. DESIGN various reinforced concrete structural systems.

## COURSE OUTLINE

**1. Flat Slab, Flat Plate & Waffle Slab**
- Analysis and design of flat plate for flexure and shear under gravity loading.
- Analysis and design of flat slabs for flexure and shear under gravity loading.
- Analysis and design of waffle slabs for flexure and shear under gravity loading.

**2. Design for Torsion Slender Columns**
- Analysis and design of slender columns subjected to combined flexure and axial loading,
- Guidelines for design of shear walls-an over view.

**3. Design of Different Types of Foundations**
- Analysis and design of eccentric, strap, strip and mat footings
- Pile caps.
- Stairs, Water tanks, Reservoirs:
- Analysis and Design of Various Types of Stairs and Staircases,
- Analysis and Design of water tanks and reservoirs.

**4. Prestressing Principles & Design Philosophy**
- Principles of prestressing, properties of high strength materials,
- Importance of high strength concrete and steel used in prestressing,

- Behavioral aspects of prestressed beams and comparison with reinforced concrete beams,
- Post tensioning and pre-tensioning techniques,
- Profiles of post-tensioned tendons, bonded and non-bonded tendons, comparison and hard-ware requirements.
- Prestress losses, immediate and time dependent losses, lump sum and detailedestimation of prestress loss.
- Analysis and design of prestressed beams.

**5. Introduction to earthquake resistant design of structures.**

**6. Design of gravity and cantilever retaining walls.**

**7. Introduction to computer aided analysis and design**

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

- To design various structures manually and to draw its structural drawings.
- To model, analyze and design various types of structures using FE based software.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theory**

One hour test(s)/Mid-semester Exam (s)
Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Final Exam

**Suggested Assessment Methods Practicals**

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. David Darwin, Charles Dolan, Arthur Nilson, (2016) Design of Concrete Structures. 15th (or latest) Edition., McGraw-Hill.
2. James K Wight and James G. Macgregor, Reinforced design: Mechanics and design, (2015), 7th (or latest) Edition.

3. Hassoun, M. N. & Al-Manaseer, A, (2015), Structural Concrete: Theory and Design, 7th (or latest) Edition.
4. Chu-Kia Wang, Charles G. Salmon, José A. Pincheira, (2017), Reinforced Concrete Design, Wiley; 8th (or latest) Edition.
5. Nilson A. H., Design of Prestressed concrete, John Wiley and Sons, Wiley, 1987.
6. Concrete Structures, Part-II, 3rd (or latest) Edition by Zahid Ahmed Siddiqi, 2016.

# MECHANICS OF SOLIDS-II

Credit Hours: 2+1=3
Pre-Requisites: Mechanics of solid-I

## DESCRIPTION

This advanced course focuses on developing students' analytical capabilities for handling complex states of stress and familiarizing them with the stability, analysis, and failure modes of structural elements. The theoretical framework encompasses topics related to beam bending and shear, including unsymmetrical bending, shear flow, shear center, analysis of curved beams, and beams on elastic foundations. The course further explores the theory of elasticity, covering the analysis of stresses and strains under the combined effects of axial, bending, and twisting forces/moments. Additionally, the course delves into torsion of thin tubes and open sections, addressing non-circular shafts, membrane analogy, and torsion in thin tubes and open sections. Theoretical insights into plasticity, plastic hinges, shape factor, and collapse mechanisms are covered, along with energy methods and their general applications. The course concludes with discussions on stability, exploring struts and columns, Euler, Rankine, and other formulas for buckling loads of columns, and stability analysis of columns under eccentric loading. Fatigue considerations, encompassing cyclic loading, discontinuities, stress concentration, corrosion fatigue, low cyclic fatigue are also addressed.

## COURSE LEARNING OUTCOMES

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

1. ANALYZE beams subjected to unsymmetrical bending, curved beams and beams on elastic foundations.
2. APPLY theory of elasticity under generalized loading.
3. DISCUSS theory of plasticity and plastic analysis of beams and frames.
4. PRACTICE experiments to study the material and structural element response under complex loadings

## COURSE OUTLINE (THEORY)

**1. Enhanced Topics Related to Beam Bending and Shear**

- Unsymmetrical bending
- Shear flow, shear center
- Analysis of curved beams
- Beams on elastic foundations

**2. Theory of Elasticity**
- Analysis of stresses and strains due to combined effect of axial, bending and twisting forces/moments
- Elementary theory of elasticity
- Equilibrium and compatibility equations
- Stress and deformation relationships
- Stress transformation
- Theories of failure

**3. Torsion of Thin Tubes and Open Sections**
- Torsion of non-circular shafts
- Membrane analogy
- Torsion in thin tubes and open sections

**4. Cylinders**
- Analysis of thin and thick cylinders

**5. Theory of Plasticity**
- Elementary theory of plasticity
- Plastic hinges
- Shape factor
- Collapse mechanism

**6. Energy Methods**
- Energy methods-General area of application and its usefulness

**7. Stability**
- Struts and columns
- Euler, Rankine and other formulas for buckling load of columns
- Stability analysis of columns under eccentric loading

**8. Fatigue**
- Fatigue due to cyclic loading
- Discontinuities and Stress Concentration
- Corrosion Fatigue
- Low Cyclic Fatigue
- $\varepsilon$-N relations

## COURSE OUTLINE (PRACTICALS)

Following practical exercises may be taken up for the course.
- Determination of the buckling load under different conditions.
- Verification of the Euler's theory of buckling.
- Bending of symmetrical and unsymmetrical cross-sections.
- Elastic deformation of curved beams
- Determination of stresses under combined bending and torsion
- Stresses in thin and thick wall cylinders

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

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

**Suggested Assessment Methods Theory**

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

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Arthur P. Boresi. & Richard J. Schmidt, Advanced Mechanics of Materials, John Wiley; 6th Edition (2002)
2. Pytel, A. & Ferdinand L. Singer, Strength of Material, Harper and Row Harper Collins College Div; 4th Sub Edition (1987)
3. R.C. Hibbeler, Mechanics of Materials, Prentice Hall; 10th edition
4. James M. Gere & Barry. J. Goodno, Mechanics of Materials, 8th Edition, CL Engineering
5. James M. Gere & Stephen P. Timoshenko, Mechanics of Materials, 4th Edition, 1997, PWS Pub Co.
6. Mechanics of Materials by Zahid Ahmed Siddiqi, 2015

# GEOTECHNICAL ENGINEERING

Credit Hours: 3 + 1 = 4
Pre-Requisites: Soil Mechanics

## DESCRIPTION

This course aims to provide students with a thorough comprehension of soil shear strength and its determination, stress distribution in soils estimated through various methods, calculation of lateral earth pressures, settlement analysis in soils, slope stability analysis using diverse methods, an introduction to earth and rockfill dams, and various techniques for soil improvement.

## COURSE LEARNING OUTCOMES

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

1. INTERPRET shear strength characteristics of soil, stress distribution, and lateral earth pressures shear strengths, earth retaining structures.
2. ANALYZE settlement of soil, and stability of slopes and excavation.
3. DESCRIBE the basics of earth and rockfill dams and various soil improvement techniques.
4. PRACTICE laboratory and field testing for strength parameters of soil

## COURSE OUTLINE (THEORY)

**1. Shear Strength**

- Concept and parameters of shear strength of soils
- Mohr Coulomb's failure envelope
- shear strength of cohesive and non-cohesive soils
- Factors affecting shear strength of soil and its applications in engineering.
- Laboratory and field tests for determination of shear strength.
- Related numerical problems

**2. Stress Distribution in Soils**

- Geo-static stresses
- Total stress, effective stress, and pore water pressure
- Vertical stresses induced due to structural loads
- Approximate methods.
- Westergaard and Boussinesq's theories
- Pressure bulb and stress isobars
- Stress distribution diagrams on horizontal and vertical planes
- Stress at a point outside the loaded area
- Newmark's influence charts

- Fadum's charts
- Related numerical problems

**3. Lateral Earth Pressure**

- Definition, pressure at rest
- Active and passive earth pressures
- Coulomb's and Rankine's theories
- Trial wedge and Culmann's method
- Earth pressure diagrams for different configurations loading
- Related numerical problems

**4. Settlement Analysis**

- Definition, total settlement, and differential settlement
- Angular distortion
- Consolidation settlement
- Elastic or immediate settlement
- Primary and secondary consolidation settlements
- Computation of elastic and consolidation settlement
- Causes of settlement and methods of controlling it
- Limits of allowable total and differential settlement
- Related numerical problems

**5. Slope Stability Analysis**

- Types of slopes
- Factors affecting slope instability and remedial measures
- Types of failure modes
- Critical slip circle and its location
- Infinite slope stability analysis
- Swedish circular method
- Ordinary method of slices
- Bishop's simplified method
- Taylor's slope stability number method
- Related numerical problems
- Earth and Rockfill Dams
- Definition and types of dams
- Components of a dam and their functions
- Coffer dams and their types
- General design considerations and typical cross sections

**7. Soil Improvement**

- Basic principles and objectives of soil improvement
- Mechanical and chemical stabilization of soil
- Different methods and their application to various soil types

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

1. To determine maximum and minimum index density (emax and emin) of cohesion less soils
2. To perform direct shear test for determining shear strength parameters of soils
3. To perform triaxial tests for the evaluation of undrained and drained shear strength of soils.
4. To perform unconfined compression test for evaluating the undrained shear strength of cohesive soil.
5. To perform standard penetration test (SPT).
6. To perform California Bearing Ratio (CBR) test on soil samples
7. To perform plate load test to evaluate the bearing capacity/settlement of soils.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing

Laboratory Demonstration

Written Assignments

Guest Speaker

Field Visits

**Suggested Assessment Methods Theorey**

One hour test(s)/Mid-term

Quiz tests, Assignments, Project Reports/Term Paper/Presentations

Final Exam

**Suggested Assessment Methods Practicals**

Laboratory Participation

Laboratory Report/Manual

Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Baraja M. Das (2020), Principles of Geotechnical Engineering, 10th Ed, Cengage Learning, Inc. USA.
2. Braja M. Das, (2020), Advanced Soil Mechanics, 5th Ed, CRC Press 734 pp.
3. Craig, R. F. (2019). Craig's Soil Mechanics, 9th ed., CRC Press, 654 pp.
4. Holtz and Kovac (2012), An Introduction to Geotechnical Engineering,

Latest Edition, Prentice Hall.
5. Doland P. Coduto (1999), Geotechnical Engineering-Principles and Practices, Prentice-Hall, Upper Saddle River, NJ 07 458.
6. Bowles J. E. (1984). Physical and Geotechnical properties of soils, 2nd Ed. McGraw-Hill, New York, 578 pp.

# FOUNDATION ENGINEERING

Credit Hours: 2+0=2
Pre-Requisites: Soil Mechanics, Geotechnical Engineering

## DESCRIPTION

In this course, students will learn how to examine a site for geotechnical investigations. They'll then be taught to design different types of shallow foundations that suit various loads and ground conditions. Additionally, the course covers the assessment of how much load deep foundations can bear in different ground situations. This knowledge helps students create sturdy and effective foundation designs based on the specific characteristics of the site and loading condition

## COURSE LEARNING OUTCOMES

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

1. CARRY OUT site characterization for geotechnical investigations.
2. DESIGN an appropriate type of shallow foundation for various loadings and ground conditions.
3. EVALUATE load bearing capacity of deep foundations for different ground conditions.

## COURSE OUTLINE

**1. Soil Exploration**

- Significance/objectives of soil exploration
- Planning of soil exploration program
- Soil exploration methods: probing, test pits, auger boring, wash percussion, rotary drilling, and geophysical methods,
- Types of soil samplers
- Disturbed and undisturbed sampling
- In situ tests: standard penetration test, cone penetration test, and field vane shear test
- Coring of rocks, Core recovery and RQD
- Soil liquefaction
- Borehole logs and subsoil exploration report

**2. Introduction to Foundations**

- Purpose and types of foundations
- Selection of foundation type and depth
- Design requirements for the foundations

- Foundation design Criteria
- Allowable settlements and angular distortion

**3. Bearing Capacity and Design of shallow foundations**

- Types of bearing capacities: gross and net bearing capacity/pressures
- Modes of bearing capacity failures
- Development of bearing capacity theory.
- Methods to evaluate soil bearing capacity: Terzaghi's, Meyerhof's, Hansen's, Vesic's, Skempton's method.
- Effects of water table on bearing capacity of soils.
- Bearing capacity from in-situ tests; SPT, CPT, Plate load test
- Presumptive values of bearing capacity.
- Design of strip, isolated, combined and raft foundations, concept of floating/compensated foundations.
- Foundations on difficult soils: design and preventive measures
- Related numerical problems.

**4. Pile Foundations**

- Introduction to deep foundations
- Types of deep foundations
- Reasons to use deep foundations.
- Classification of piles
- Methods of installation of Piles
- Load transfer mechanism of piles
- Load carrying capacity of piles in different soils.
- Empirical correlations for pile capacity evaluation
- Settlement of Piles.
- Pull out resistance of piles.
- Pile driven formulas.
- Negative skin friction
- Pile load test and interpretation.
- Pile group capacity, group efficiency, elastic, and consolidation settlement of group of piles, uplift capacity of pile group.
- Rock socketed piles

**5. Introduction to relevant software**

- GeoStudio, Plaxis etc.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

- Lecturing (audio/video aids)
- Written Assignments/Quizzes

- Tutorials and case studies relevant to engineering disciplines.
- Semester project
- Guest speaker
- Industrial/field visits, group discussion & report writing.

**Suggested Assessment Methods Theory**

- One hour test(s)/Mid-term
- Quiz tests, Assignments, Project Reports/ Term Paper/ Presentations
- Final Exam

## SUGGESTED TEACHING & ASSESSMENT METHODS

1. Baraja M. Das (2017). Principles of Foundation Engineering, 9th Ed, Cengage Learning, Inc., USA.
2. Robert Wade Brown (2004), Practical Foundation Engineering Handbook, McGraw-Hill.
3. Donald P. Coduto (2001), Foundation Design: Principals and Practice, (Latest Ed), Prentice Hall, NJ.
4. Tomlinson, M. J. (2001) Foundation Design and Construction, 7th Ed (or latest), Pearson Education.
5. Bowles, J. E. (1998), Foundation Analysis and Design, 6th Edition (or latest ed), McGrow-Hill International Press.
6. Smith and Ian Smith (1998), Elements of Soil Mechanics, 7th Ed (or latest), Blackwell Science.

# PAVEMENT ANALYSIS & DESIGN

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

## DESCRIPTION

This course will give students a detailed understanding of about the fundamentals of Pavement Engineering. The course will also provide detailed guidance on both quantitative and computerized techniques for solving problems related to Pavement Design and Analysis. Students shall be able to apply principles of Pavement Engineering to evaluate, analyze and design asphalt mix and asphalt pavement.

## COURSE LEARNING OUTCOMES

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

1. EXPLAIN the fundamentals of pavement engineering.
2. CHOOSE/APPLY principles of pavement engineering to analyse and design pavements.
3. ANALYZE/INVESTIGATE appropriate pavement design solution considering indigenous conditions.

## COURSE OUTLINE (THEORY)

**1. Concept of Pavement Design and Material Specification**

- The Pavement, Types of Pavements, Principle of Pavement Design
- Approaches to Pavement Design, Pavement Design Standards
- Resilient behavior of Unbound Granular Material
- Asphalt Binder Rheology, Asphalt Mixtures Design (Marshall Method of Mix Design)
- Introduction to SHRP Specification and Superpave Method of Mix Design

**2. Pavement Design Methods and Analysis**

- Axle Load, Equivalent Single Axle Load, Classification of Commercial Vehicles, Axle Loading of Commercial Vehicles, influence of Axle configuration and Loading on the Damaging Effect
- Contact Area between the Tyre and Road, Repetition, and Impact Factors
- Methods of Pavement Design (Empirical ~Mechanistic), AASHTO Pavement Design Method, Group Index Method, CBR Method, Wester-Guard method, Road Note, AASHTO 1993 Pavement Design Methodology and practice, Road Note 31 Pavement Design Methodology
- Concept of Mechanistic-Empirical Pavement Design, Stresses and Strains

in Flexible & Rigid Pavements.
- Introduction to MEPDG Software

**3. Pavement Evaluation and Rehabilitation**
- Pavement Failures, Construction and Maintenance
- Pavement Evaluation and Rehabilitation, Introduction to Non-Destructive Testing
- Recycling Methods and Reclaimed Asphalt Pavement (RAP), Pavement Drainage System and Design

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.
1. To determine Particle shapes (Elongation & Flakiness Index) of various aggregate samples and then to discuss the results.
2. To determine Resistance to Degradation of coarse aggregate by Abrasion and Impact in the Los Angeles Abrasion Machine.
3. To determine Penetration grade of Bituminous Sample.
4. To determine the Softening Point of Bituminous Sample by using Ring & Ball Apparatus.
5. To determine the Flash and Fire Point of Bituminous Sample by Cleveland Open Cup Apparatus.
6. To determine the Ductility of Bituminous Sample Using a Ductilometer.
7. To Perform the CBR Test for the Sub-grade on the given Soil sample.
8. Non-Repetitive Static Plate Load Test of Soils and Flexible Pavement Components for Use in Evaluation and Design of Airports and Highway Pavements.
9. To find out JMF for Specified Paving Job (Marshall Method).

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theorey**

One hour test(s)/Mid-term

Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Final Exam

**Suggested Assessment Methods Practicals**

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Yang H. Huang, (2003), Pavement Analysis and Design, 2nd Edition (or latest), Pearson Higher Education.
2. Fred. L. Mannering and Scott S. Washburn, (2013), Principles of Highway Engineering and Traffic Analysis, 5th Edition (or Latest), John Wiley & Sons. NY.
3. Asphalt Institute, (2005), Mix Design Methods for asphalt concrete and other Hot-Mix Types, MS-2, 2nd Edition (or latest), Asphalt Institute.
4. Asphalt Institute, (2005), Superpave Mix Design, SP-2, 3rd Edition, Asphalt Institute.

# HYDRAULICS ENGINEERING

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

## DESCRIPTION

To enable students to learn fundamentals of hydraulic engineering, particularly related to open channel flow, flow through pipes, hydraulic structures, dam and hydropower engineering. In this course student will learn the application of the principles of fluid mechanics to problems dealing with the collection, storage, control, transport, regulation, measurement, and use of water.

## COURSE LEARNING OUTCOMES

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

1. DISCUSS dimensional analysis, similitude and basic principles of hydraulic structures.
2. ANALYZE various hydraulic structures in open channel flow.

## COURSE OUTLINE

**1. Steady Flow in Open Channel**

- Specific energy and critical depth
- Dynamic equation of gradually varied flow, surface profiles and back water curves
- Humps and constrictions Hydraulic jump
- Broad crested weirs, venturi flume and critical depth meters

**2. Unsteady Flow**

- Flow through pipes, orifices and over weirs under varying heads
- Unsteady flow through pipe lines, water hammer, instantaneous and slow closure of valves
- Surges in open channel

**3. Dimensional Analysis and Similitude**

- Similitude in hydraulic models
- Similitude requirements, geometric, kinematics and dynamics similarities, dimensionless numbers and their significance
- Releigh's method
- Buckingham's PI-theorem and its application, physical models, techniques and analysis
- Introduction to numerical models

**4. Hydraulic Structures**
- Canal Falls, flumes, canal outlets
- Cross drainage works: types and functions

**5. Dams and Hydro Power Engineering**
- Selection of hydropower sites
- Components and layout of hydropower schemes
- Types of storage dams, forces on dams, design of gravity dams
- Reservoir engineering, operation and regulation of storage reservoirs
- Sediment Transport in Channels
- Sedimentation Problems in Reservoirs

**6. Drainage**
- Definition, Land reclamation Surface Drainage
- Subsurface Drainage
- Estimation of discharge capacity of Cross-drainage structures Disposal of drainage effluents

**7. Advanced Topics in Hydraulics**
- Modern trends in hydraulic engineering
- Computational fluid dynamics (CFD)
- Case studies and real-world applications

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.

1. To measure water level and velocity along the channel.
2. To estimate flow rate through changes in the channel section.
3. To analyze water hammer phenomena through water hammer apparatus.
4. Characterization of the hydraulic jump.
5. To study the subcritical and supercritical flows.
6. Application and understanding of Manning formula.
7. To demonstrate flow over weir in open channel.
8. Perform experiment on flume to plot E ~ y diagram for uniform flow.
9. To examine the flow through sluice gate in open flow channel.
10. To produce a hydraulic jump in tilting flume.
11. Relationship between backwater level and discharge level.
12. To examine the sediments transport and settling mechanisms.
13. Simulation of water structure interaction using hydraulic modeling software.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theory**

Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Mid term and final term exams
Suggested Assessment Methods Practicals
Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Roberson J. A., Cassidy J. J., and Chaudhry M. H., (1998) Hydraulic Engineering, John Wiley & Sons
2. Wynn P., (2014) Hydraulics for Civil Engineers, ICE Publishing.
3. Lindell J. E., Moore W. P., and King H. W., (2018), Handbook of Hydraulics, 8th Edition, McGraw Hill
4. David, A. Chin, (2010) Water Resources Engineering, 2nd Edition, John Wiley & Sons

## IRRIGATION ENGINEERING

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

### DESCRIPTION

This course aims to introduce knowledge and skills namely the principles and basics of irrigation methods, design of irrigation systems and irrigation network for the purpose of irrigation applied to traditional and modern irrigation systems.

### COURSE LEARNING OUTCOMES

By the end of this course, students will be able to:
1. EXAMINE the various irrigation concepts and soil-water-crop relationships.
2. ANALYSE problems related to irrigation canals and other irrigation systems.

### COURSE OUTLINE (THEORY)

**1. Introduction**
- Definition, Necessity, Scope, Benefits, and ill effects of irrigation engineering.

**2. Methods of Irrigation**
- Irrigation methods
- Factors affecting choice of irrigation methods
- Pressurized and non-pressurized methods
- Uniformity coefficient

**3. Soil-Water-Crop Relationship**
- Soil and its physical and chemical properties
- Root zone soil water
- Crops of Pakistan and crop rotation

**4. Water Requirement of Crops**
- Functions of irrigation water
- Standards for irrigation water
- Relationship between duty and delta
- Factors affecting and improving duty
- Classes of soil water
- Equilibrium points-soil moisture tension
- Depth of effective root zone

- Depth and Frequency of irrigation

**5. Canal Irrigation System**
- Alluvial and non-alluvial canals
- Alignment of canals
- Distribution system for canal irrigation
- Determination of canal capacity
- Canal losses and Channel section for minimum seepage loss

**6. Design Interpretation of Earthen/Alluvial Channels**
- Lacey's theory, Rational approach, Channel design software

**7. Lined Channels**
- Canal Lining and its types
- Permissible velocities in lined channels
- Design interpretation of lined irrigation channels

**8. Diversion Head Works**
- Weir and barrage
- Types and components of diversion weir
- Head regulator and cross regulator
- Canal regulation and silt control at the head works
- Silt excluders and silt ejectors

**9. Canal Outlets**
- Types, Essential requirements and characteristics of outlets
- Tail cluster and tail escape

**10. Water logging and salinity**
- Causes and effects of water logging
- Reclamation of waterlogged soils
- Drains and tube wells
- Causes and effects of salinity and alkalinity of lands in Pakistan.

## COURSE OUTLINE (PRACTICALS)

The following practicals may be carried out for the course.
- Evapotranspiration Measurement Using Simple Pan Evaporimeters
- Demonstration of Irrigation Furrows: Water Distribution and Efficiency
- Measurement of Infiltration Rate in Soils
- Measuring Runoff in Simple Sloped Surfaces
- Analysis of Efficiency in Gravity-Based Irrigation Systems
- Investigation of Soil Erosion Control Techniques
- Analysis of Irrigation Water Conveyance Efficiency in Canals

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theory**

Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Mid- and final-term exam

**Suggested Assessment Methods Practicals**

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Peter, W., and Yitayew, M., (2015) Irrigation and drainage engineering, Springer
2. Hossain, A., Practices of irrigation & on-farm water management, Springer
3. Singh V, P., and Su Q., (2022) Irrigation Engineering (Principles, Processes, Procedures, Design, and Management), Cambridge University Press

# GEOLOGY FOR ENGINEERS

Credit Hours: 2+0=2
Pre-Requisites: Nil

## DESCRIPTION

This course introduces students to various branches of geology, including the constituents of the Earth, rock formation, rock weathering, volcanic eruptions, landslides, and earthquakes. It covers fundamental concepts of general geology and hydrogeology, illustrating their practical applications in the construction of underground tunnels, and other infrastructure projects.

## COURSE LEARNING OUTCOMES

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

1. DESCRIBE different branches of geology, constituents of earth, formation of rocks, and structural features of strata.
2. EXPLAIN natural geological phenomena such as weathering, erosion, volcanic eruption, land sliding, and earthquakes.
3. DISCUSS different concepts of general geology and hydrogeology and their application to the construction of underground tunnels other infrastructure projects.

## COURSE OUTLINE (THEORY)

**1. General geology**

- The earth as planet and process of external origin
- Weathering and erosion
- Transportation, and deposition, of rock material by geological agents
- Processes of internal origin volcanism, earthquakes, intrusion and metamorphism
- Rock cycle, diastrophism, and isostasy.

**2. Elements of structural geology**

- Folds and faults, joints, fractures, and cleavages
- Unconformities, primary and secondary structural features of rock
- Expression of geological features on geological field maps
- Construction of cross sections and geological mapping.

**3. Minerals and rocks**

- Important minerals and rocks, and their identification
- Igneous, sedimentary and metamorphic rocks

- Fossils
- Basic principles of stratigraphy and Geologic time scale
- Brief introduction of local geology from boring logs.

**4. Applied geology**

- Application of geology to planning and design of various civil engineering infrastructure like dams, reservoirs, bridges, application of geology to building materials and soils.

**5. Earthquakes**

- Theory of plate-tectonics, seismic waves, seismology
- Prediction of earthquakes and preventive measures against earthquakes
- Ground subsidence
- Earthquake zoning of Pakistan

**6. Stability of rock slopes**

- Various types of rock failures and factors affecting the stability of rock slopes
- Analysis, and calculation of factor of safety
- Types of Land Sliding: Slump, Rockslides and Rock Falls
- Causes of landslides and remedial measures.

**7. Hydrogeology**

- Introduction to Wells, Springs, Streams, Ground Water, and Glaciers
- Types of Wells, Springs, Streams, Ground Water, and Glaciers.

**8. Tunnelling**

- Introduction to Tunnels
- Types of Tunnels
- Tunnel Construction Methods in Rocks
- Geological Survey Prior to Tunnelling
- Lining of Tunnels and Its Sections.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

- Lecturing (audio/video aids)
- Written Assignments/Quizzes
- Tutorials and case studies relevant to engineering disciplines.
- Semester project
- Guest speaker
- Industrial/field visits, group discussion & report writing.

**Suggested Assessment Methods Theory**

- One hour test(s)/Mid-term
- Quiz tests, Assignments, Project Reports/ Term Paper/ Presentations
- Final Exam

## RECOMMENDED TEXT AND REFERENCE BOOKS


1. Banger, K. M. (1988), A Textbook of General AND Engineering Geology, Latest Edition.
2. N.T Price, N. T. & Cosgrove, I. W. (1990), Analysis of Geological Structures, Latest Edition.
3. Steven L. Kramer, (2010), Analysis of Geological Structures, Latest Edition
4. Blyth, F. G. H. (2003), A Geology for Engineers, Latest Edition, Arnold International.
5. Legget, R. F. (2010), Geology and Engineering, Latest Edition, McGraw Hill International
6. Richard and Busch (2019), Laboratory Manual in Physical Geology 9th Edition (or latest), American Geological Institute.
7. Frederick K. Lurgens (2016), Earth: An Introduction to Physical Geology, 12th Edition (or latest), Pearson Publishers.

# ARCHITECTURE & TOWN PLANNING

Credit Hours: 2+0=2
Pre-Requisites: Nil

## DESCRIPTION

This course will give students an introductory understanding of various components of various types of buildings from an architectural point of view. Moreover, this course will provide basic guidance on ancient and modern forms of living and various terms related to planning and development of inhabitant areas.

## COURSE LEARNING OUTCOMES

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

1. EXPLAIN various ancient and modern forms of living.
2. DESCRIBE terms related to planning and development of inhabitant areas.

## COURSE OUTLINE

**1. Architecture**

- Historical Development
- General introduction to history of architecture
- Emergence/Development of Islamic Architecture
- Geographical, climatic, religious, social and historical influences Architectural beauty

**2. Qualities, Factors and Use of Materials**

- Strength, vitality, grace, breadth and scale Proportion
- Colour and balance
- Stone, wood, metals, concrete, composites, ceramics

**3. Architectural Aspects of Building Planning**

- Walls and their construction
- Openings and their position, character and shape Roofs and their development and employment
- Columns and their position, form and decoration
- Moulding and their form decoration
- Ornament as applied to any buildings

**4. Town Planning**

- Definitions
- Trends in Urban growth
- Objectives of town planning

- Modern planning in Pakistan and abroad

**5. Preliminary Studies**

- Study of natural resources, economic resources, legal and administrative problems
- Civic surveys
- Preparation of relevant maps

**6. Land Use Patterns, Street Patterns**

- Various theories of land use pattern
- Location of Parks and recreation facilities
- Public and semi-public buildings
- Civic centers, commercial centers, local shopping centers
- Public schools, industry & residential areas
- Layout of streets, road crossing & lighting Community planning

**7. City Extensions and Urban Planning**

- Sub Urban development
- Neighborhood Units
- Satellite Towns and Garden City
- Issues related to inner city urban design and emergence/upgradation of squatter settlements.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Written Assignments
Guest Speaker

**Suggested Assessment Methods Theorey**

One hour test(s)/Mid-term
Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Final Exam

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Dan Cruickshank, Sir Banister Fletcher's A History of Architecture, Architectural Press; 20th Edition (September 25, 1996)
2. Leonard Benevolo; Origins of Modern Town Planning, MIT Press, 15-Aug- 1971
3. Sir Rymond Unwin, Town Planning in Practice, FQ Legacy Books (December 31, 2010)

# MODELLING AND SIMULATION

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

## DESCRIPTION

Introduction to fundamental concepts, techniques, and tools for creating mathematical models and conducting simulations to analyze complex systems. Covers mathematical modelling principles, simulation techniques, model validation, optimization, and real-world applications. Hands-on experience with simulation software. Ideal for engineering students seeking to enhance problem-solving skills and decision-making in engineering domains.

## COURSE LEARNING OUTCOMES

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

1. Understand the fundamental principles and concepts of mathematical modelling and simulation.
2. Apply modelling and simulation tools to solve complex engineering problems across diverse domains.
3. Demonstrate the ability to interpret simulation results and make informed decisions based on analysis

## COURSE OUTLINE

**Simulation**

- Prepare Model Inputs and Outputs
- Configure Simulation Conditions
- Run Simulations
- View and Analyze Simulation Results
- Test and Debug Simulations
- Optimize Performance
- Simulation Guidelines & Best Practices

**Modeling**

- Design Model Architecture
- Manage Design Data
- Design Model Behavior
- Configure Signals, States, and Parameters
- Configure Inputs and Visualizations
- Analyze and Remodel Design
- Test Model Components
- Modeling Guidelines & Best Practices

## COURSE OUTLINE (PRACTICALS)

- Introductions to programming with MATLAB
- Find the response of a lumped variable model expressed in terms of transfer function using MATLAB for input of (i) unit step function (ii) unit impact function and (iii) unit ramp function
- Use of Simulink in MATLAB for engineering problems
- Use of Neural Network in MATLAB for engineering problems
- Use of Fuzzy inference system (FIS) and Adaptive Neuro-Fuzzy Inference System (ANFIS) in MATLAB for engineering problems
- Monte Carlo simulation

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

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

**Suggested Assessment Methods**

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

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Introduction to Matlab for Engineering Students by David Houcque, Northwestern University latest edition.
2. https://www.mathworks.com/help/simulink/simulation.html
3. https://www.mathworks.com/help/simulink/modeling.htm

# OCCUPATIONAL HEALTH AND SAFETY

Credits: 01
Pre-Requisite: Nil

## DESCRIPTION

This course introduces the student to the study of workplace occupational health and safety. The student will learn safe work practices in offices, industry and construction as well as how to identify and prevent or correct problems associated with occupational safety and health in these locations as well as in the home.

## COURSE LEARNING OUTCOMES

Upon successful completion of this course, the student will be able to:

1. IDENTIFY hazards in the home, laboratory and workplace that pose a danger or threat to their safety or health, or that of others.
2. CONTROL unsafe or unhealthy hazards and propose methods to eliminate the hazard.
3. PRESENT a coherent analysis of a potential safety or health hazard both verbally and in writing citing the Occupational Health and Safety regulations and other supported legislation.
4. DEMONSTRATE a comprehension of the changes created by WHMIS and OSHA legislation in everyday life.

## COURSE OUTLINE

1. **Health and Safety Foundations**
   - Nature and scope of health and safety
   - Reasons/benefits and barriers for good practices of health and safety
   - Legal framework 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
2. **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)

**3. 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

**4. 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

**5. 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:**

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

## 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.

# CONSTRUCTION ENGINEERING

Credit Hours: 2 + 0 = 2
Pre-Requisites: Nil

## DESCRIPTION

The course objective is to familiarize students with traditional and modern methodologies, tools, and techniques used in the construction industry. The course will also develop student's ability of proposing method statements of construction projects according to sustainable practices considering regulatory environment, contractual agreement, design drawings and specifications.

## COURSE LEARNING OUTCOMES

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

1. CARRY out analysis for the capacity of various construction equipment using basic equations of economics.
2 CATEGORIZE different types of construction techniques and methodologies for different civil engineering projects

## COURSE OUTLINE (THEORY)

1. Introduction to Construction Industry and Project Management
2. Engineering Costs and Estimation, Lifecycle Cost, Cash Flow Diagram
3. Value Engineering, Earned Value Analysis and Economic Decision Analysis
4. Network Analysis Techniques, CPM, PERT etc.
5. Procurement and Contract Management, Bid and Tender
6. Construction Safety, Accidents, and Risk Management
7. Innovative Trends in Construction Industry
8. Introduction to Project Management Software (Primavera/MS Project)

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

- Lecturing
- Laboratory Demonstration
- Written Assignments
- Guest Speaker

**Suggested Assessment Methods Theory**

- One hour test(s)/Mid-term
- Quiz tests, Assignments, Project Reports/Term Paper/Presentations
- Final Viva-voce/Exam

## RECOMMENDED TEXT AND REFERENCE BOOKS


1. Jimmie Hinze, Construction Contracts ISBN: 978-0·07-339785-6, McGraw-Hill.
2. J.K.Yates (2010), Engineering and Construction Law and Contracts, ISBN-10: 0135033527 ISBN-13: 978-0135033524, Pearson.
3. John Murdoch and Will Hughes Fourth Edition, Construction Contracts, ISBN 10: 0415393698 ISBN-13: 978-0415393690, Routledge.
4. Donald G. Newnan, Ted G. Eschenbach, Jerome P. Lavelle , Engineering Economic Analysis, Ninth Edition, ISBN 0-19-516807-0, Oxford University Press.
5. Chan S Park, Fundamentals of Engineering Economics, ISBN-10: 0132775425 ISBN-13: 978-0132775427, Pearson.
6. James P Lewis, Project Planning Scheduling and Control 4th Edition, ISBN 0-07-146037-3, McGraw-Hill.
7. Lingard, H. and Rowlinson, S. (2005), Occupational Health and Safety in Construction Project Management, ISBN-10: 0419262105 ISBN-13: 978-0419262107, Routledge.
8. Martin Loosemore (2003), HRM in construction projects: Strategic and operational approach ISBN 0-415-26163-5, ISBN 0415-26164-3, Routledge.
9. James M. Kouzes, Barry Z. Posner (2017). The Leadership Challenge, ISBN: 978-1-119-27896-2, Jossey-Bass.
10. Lu, Weisheng, Chi Cheung Lai, and Tung Tse. BIM and Big Data for Construction Cost Management. Routledge, 2018.
11. Journal of Automation in Construction

# HGIHWAY AND TRAFFIC ENGINEERING

Credit Hours: 2+0=2
Pre-Requisites: Nil

## DESCRIPTION

This course will give students a detailed understanding of about highway and traffic engineering fundamentals. The course will also provide detailed guidance on the understanding of the relevant concepts of roadways, geometrics and traffic engineering by adopting suitable principles of transportation engineering. Students shall be able to apply principles of highway and traffic engineering to get a better functional performance from roads.

## COURSE LEARNING OUTCOMES

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

1. EXPLAIN the fundamentals of highway and traffic engineering.
2. CHOOSE/APPLY appropriate principles of transportation engineering in geometric design using various parameters.
3. ANALYZE relevant available information in order to provide appropriate solution to traffic.

## COURSE OUTLINE

**1. Highway Engineering**

- Introduction to Transportation systems (modes, models, infrastructure etc)
- Highway Planning; Principles, Location Survey in Rural & Urban Areas, Location Controls.
- Elements of a Typical Cross-Section of Road, Types of Cross-sections
- Classification of Highways, Highway Materials, Types & Characteristics, Specification & tests.

**2. Highway Geometric Design (Alignments)**

- Introduction to Geometric Design,
- Horizontal Curves, Super Elevation,
- Vertical Curves,
- Grade Line, Transition Curve, Curve Widening, Sight Distance Requirements, Introduction to Civil 3D

**3. Traffic Engineering**

- Traffic studies & Estimates, Speed-flow-density relationship, Traffic Lane Capacity, Level of Service, Design Speed.
- Traffic Safety (signs, marking, signals), Channelization

- Design of Intersection at Grade & Grade Separated (Access control)
- Parking and Accident Studies, Conflict analysis
- Intelligent Transportation System (ITS), Advanced Transportation Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Delays and
- Que formation, Que theory (DD1 & MD1)
- Public Transport System, Rapid Transit modes (BRT), Basic methods for estimating public transport demand, Corridor and network development.
- Traffic Impact assessment & Mitigation Planning
- Introduction to Vissim/Synchro Plus Sim Traffic

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theorey**

One hour test(s)/Mid-term
Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Final Exam

**Suggested Assessment Methods Practicals**

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

## SUGGESTED TEACHING & ASSESSMENT METHODS

1. Fred. L. Mannering and Scott S. Washburn, (2013), Principles of Highway Engineering and Traffic Analysis, 5th Edition (or Latest), John Wiley & Sons. NY.
2. Salter R. J., and Hounsell, N.B., (1996), Highway Traffic Analysis and Design, 3rd Edition (or latest), Palgrave Macmillan, Red Globe Press London.
3. Roger P. Roess, Elenna S. Prassas and William R. Mc. Shane, (2011), Traffic Engineering 4th Edition (or latest), Pearson Higher Education.

# STEEL STRUCTURES

Credit Hours: 2 + 0 = 2
Pre-Requisites: Nil

## DESCRIPTION

The main purpose of this course is to differentiate between different design philosophies related to working stress and ultimate strength conditions. This course will also help the students to classify types of loads and load combinations, types of steel structures, General steel manufacturing and historic back ground, various processes and property modifications by Quenching, Tempering, Annealing and obtaining specific steel properties, residual stresses and their effect on various structural elements (tension, flexure, compression).

## COURSE LEARNING OUTCOMES

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

1. DESCRIBE the theories and models suitable for the analysis and design of structural steel members.
2. DESIGN structural steel members under axial loads, flexure and shear.
3. DESIGN connections in structural steel members.

## COURSE OUTLINE

**1. Introduction**

- Use of steel as a structural material
- Mechanical properties
- Types and shapes of structural steel members
- Specifications and design codes
- Design philosophies, load and safety factors.

**2. Fundamentals of Working Stress Method**

- Overview of Allowable Stress Design (ASD)
- Service load and allowable stresses

**3. LRFD Method of Design**

- Factor of safety, loads and load combination.
- Concept of load and resistance factors
- Plastic design and limits on design
- Analysis and design of tension members
- Analysis and design of Compression Members.
- Local and overall stability
- Euler's buckling load in columns

**4. Analysis and design of beams**

- Compact, non-compact and slender sections
- Bending strength
- Shear Strength
- Lateral torsional buckling.
- Biaxial Bending
- Purlins, sag rods

**5. Beam-column and axial-flexure interaction**

- Second order effects
- Moment magnification.
- Plate girder proportioning and design.

**6. Simple welded and bolted connections**

**7. Overview of moment and shear connections**

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing

Written Assignments

Guest Speaker

Field Visits

**Suggested Assessment Methods Theory**

One hour test(s)/Mid-term

Quiz tests, Assignments, Project Reports/Term Paper/Presentations

Final Exam

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Steel Design by William T. Siggui, 6th edition
2. Structural Steel Design by Jack C. McCormac, 5th Edition
3. American Institute of Steel Construction-AISC Manual 15th Edition

# GEOINFORMATICS ENGINEERING

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

## DESCRIPTION

This course is designed to familiarise the students of Civil Engineering with the field of Geoinformatics which has at its core the technologies supporting the processes of acquiring, analysing and visualizing spatial data. This includes Field Surveying, Photogrammetry, Geographic Information System (GIS), Global Navigation Satellite System (GNSS) and Remote Sensing. However in this course the students will be only studying introductory topics on remote sensing, GIS and GNSS.

## COURSE LEARNING OUTCOMES

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

1. Demonstrate the ability to comprehend ERDAS Imagine and Arc GIS software and their usage.
2. Apply the working principles of remote sensing, GIS and their respective data acquisition technique(s).
3. Illustrate the differences between spatial/non-spatial data, raster and vector data, spatial analysis and their applications in GIS environment.
4. Produce GIS solutions for a variety of engineering projects by using modern field survey instruments for data acquisition and processing the acquired Geo-spatial data using modern GIS and Remote sensing software.

## COURSE OUTLINE

**1. Introduction to Geo Informatics and Resources of Information**

- Photogrammetric surveying
- Satellite System
- Aerial and Satellite photogrammetry

**2. Geographic Information System (GIS)**

- Fundamentals of GIS
- Spatial Data types and acquiring consideration
- Data models and structures
- Coordinate System
- Datum and map projection and their transformation
- Attribute-based operation
- Introduction to Spatial Analysis

**3. Remote Sensing (RS)**

- Basic Concepts
- Physicals basis of Remote Sensing
- Earth Resources Satellites / Platforms
- Sensors
- Types of Resolutions
- Geo-referencing
- Image Processing Techniques and Classification
- Global Positioning System (GPS)
- Navigational Satellites
- Positioning Systems (GLONASS, GPS & Galileo)
- Fundamentals and Elements of GPS
- System Operation & Characteristics
- Errors and Atmospheric effects
- Differential GPS (DGPS)

## COURSE OUTLINE (PRACTICALS)

- Introduction to Arc GIS interface and its related terminologies / tools.
- To locate the features on the ground / measure lengths and area of the object using Google Earth /Arc GIS.
- To execute the basic commands of point, polyline and polygon layer in Green Valley map.
- To reference, digitize and edit the feature in map / raster image using Arc GIS.
- To find the coordinates of a point on ground using GPS instrument. To generate a point showing the coverage of Met. Station in map.
- To model and analyze spatial dataset using tiff file/ satellite image.
- To convert coordinate and projection system of a map using GIS software.
- To apply image processing techniques using remote sensing software.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theory**

One hour test(s)/Mid-term

Quiz tests, Assignments, Project Reports/Term Paper/Presentations

Final Exam

## RECOMMENDED TEXT AND REFERENCE BOOKS

1. Remote Sensing And Image Interpretation, Thomas M. L., Ralph W. K., 5th Edition
2. Introduction To Geographic Information Systems, Chang K. T., 3rd Edition

## OCCUPATIONAL HEALTH AND SAFETY

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

### DESCRIPTION

In this course students will acquire knowledge of safe work practices applicable to office, industry, and construction settings. Additionally, they will learn how to identify, prevent, and address issues related to occupational safety and health, not only within professional environments but also in domestic settings.

### COURSE LEARNING OUTCOMES

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

1. IDENTIFY hazards in the home, laboratory and workplace that pose a danger or threat to their safety or health, or that of others.
2. CONTROL unsafe or unhealthy hazards and propose methods to eliminate the hazard.
3. PRESENT a coherent analysis of a potential safety or health hazard both verbally and in writing citing the Occupational Health and Safety regulations and other supported legislation.
4. DEMONSTRATE a comprehension of the changes created by WHMIS and OSHA legislation in everyday life

### COURSE OUTLINE

**1. Health and Safety Foundations**

- Nature and scope of health and safety
- Reasons/benefits and barriers for good practices of health and safety
- Legal framework 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

**2. 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)

**3. 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

**4. 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

**5. 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 & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing (audio/video aids)

Written Assignments/Quizzes

Tutorials and case studies relevant to engineering disciplines.

Semester project

Guest speaker

Industrial/field visits, group discussion & report writing.

**Suggested Assessment Methods Theory**

Mid-semester exam, report writing/presentation, assignment, project report, quizzes, end-semester exam.

One hour test(s)/Mid-term

Report writing/presentation.

Quiz tests/assignments/project reports

Final Exam

## 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.

Annexure A

## NON-EXHAUSTIVE LIST OF CONSIDERED KEY PHRASES IN UN SDGs

## FOR MAPPING WITH BACHELORS OF ENGINEERING PROGRAM

SDG-1 (1.5 …… reduce their exposure and vulnerability to climate-related extreme events …..)
SDG-2 (2.4 …………….. implement resilient agricultural practices ………………. adaptation to climate change, extreme weather, drought, flooding and other disasters ….)
SDG-3 (3.6 …… halve the number of global deaths and injuries from road traffic accidents)
SDG-3 (3.9 ……… air, water and soil pollution and contamination)
SDG-4 (4.3 ……… ensure equal access for all women and men …, including university ……..)
SDG-4 (4.4 ……….. increase the number of youth and adults ……., for employment, decent jobs and entrepreneurship)
SDG-4 (4.5 ……… eliminate gender disparities in education ……….)
SDG-4 (4.7 ………. all learners acquire the knowledge and skills needed to promote sustainable development………)
SDG-4 (4.c ……… substantially increase the supply of qualified teachers……….)
SDG-5 (5.1 End all forms of discrimination against all women and girls everywhere)
SDG-5 (5.5 …… Ensure women's full and effective participation ……… at all levels……..)
SDG-6 (6.1 … access to safe and affordable drinking water for all)
SDG-6 (6.2 … adequate and equitable sanitation and hygiene for all and end open defecation ..)
SDG-6 (6.3 ……… improve water quality by reducing pollution……)
SDG-6 (6.4 …… increase water-use efficiency across all sectors ………….)
SDG-6 (6.5 …… implement integrated water resources management at all levels……..)

SDG-6 (6.a …… water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies……………………….)
SDG-6 (6.b …… improving water and sanitation management……..)
SDG-7 (7.b … expand infrastructure…..)
SDG-8 (8.3 …… decent job creation, entrepreneurship……….)
SDG-8 (8.6 ……… reduce the proportion of youth not in employment, education or training….)
SDG-8 (8.8 ……… promote safe and secure working environments for all workers……..)
SDG-9 (9.4 …… greater adoption of clean and environmentally sound technologies and industrial processes……………………….)
SDG-9 (9.5 …… encouraging innovation and substantially increasing the number of research and development workers……………………….)
SDG-9 (9.b Support domestic technology development, research and innovation in developing countries…………………….)
SDG-9 (9.c significantly increase access to information and communications technology…….)
SDG-10 (10.2 ……… empower and promote the social, economic ….. inclusion of all……)
SDG-11 (11.2 …… access to safe, affordable, accessible and sustainable transport systems for all………)
SDG-11 (11.5 ……… reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses …… by disasters, including water-related disasters………
SDG-11 (11.6 ……….. special attention to air quality and municipal and other waste management………)
SDG-11 (11.a ……… positive economic, social and environmental links between urban, peri-urban and rural areas…………………….)
SDG-11 (11.c ……… resilient buildings utilizing local materials)
SDG-12 (12.2 …… achieve the sustainable management and efficient use of natural resources)
SDG-12 (12.4 …… achieve the environmentally sound management of chemicals and all wastes throughout their life cycle………….)
SDG-12 (12.5 ……….. substantially reduce waste generation through prevention, reduction, recycling and reuse)
SDG-12 (12.7 Promote public procurement practices that are sustainable………)
SDG-12 (12.8 ……….. relevant information and awareness for sustainable development……)

SDG-12 (12.a ………. more sustainable patterns of consumption and production)
SDG-13 (13.1 Strengthen resilience and adaptive capacity to climate related hazards and natural disasters……..)
SDG-13 (13.2 Integrate climate change measures…………………)
SDG-13 (13.3 Improve education, awareness-raising ……………. on climate change mitigation, adaptation, impact reduction and early warning……..)
SDG-13 (13.b ... effective climate change-related planning and management………….)
SDG-14 (14.1 ……… reduce marine pollution of all kinds……………………..)
SDG-14 (14.3 ………. impacts of ocean acidification……………………)
SDG-15 (15.3 ……… land affected by desertification, drought and floods………….)
SDG-16 (16.3 ……… rule of law at the national and international levels……………………..)
SDG-16 (16.5 …… reduce corruption and bribery in all their forms)
SDG-16 (16.6 ……… effective, accountable and transparent institutions at all levels……..)
SDG-17 (17.1 Strengthen domestic resource mobilization…………………)
SDG-17 (17.13 ……… macroeconomic stability……………………..)
SDG-17 (17.17 ……… effective public, public private and civil society partnerships……)

Annexure B

# MAPPING GUIDE OF SELECTED COURSES WITH SDGs

## 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, with emphasis on UN SDGs.

Mapped SDGs:

| | |
|---|---|
| DG-13<br>Climate Change | 13.2 Integrate climate change measures………………. |

## 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 OUTLINE

**1. 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.

**2. 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.

**3. 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.

**4. 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

**5. 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
- Planning for community inclusiveness
- Societal Obligation of Engineers

**6. 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, UN SDGs.

**7. 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

**8. Climate Change and Ecological Friendliness from Engineering Perspective 173**

- 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)

**9. 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.

**10. 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.

**11. Engineering Intervention for Social Stratification**

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

**12. Case Studies of Different Development Projects in Social Context**

## SUGGESTED TEACHING & ASSESSMENT METHODS

**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

**Suggested Assessment Methods Theory**

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, 2018.174
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.APhilosophyof Technology: FromTechnical Artefacts to Socio technical systems.
7. Mitcham,C.,andMunoz,D.2010.HumanitarianEngineering. Morganand Claypool Publishers. 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

# REINFORCED CONCRETE DESIGN-I

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

## DESCRIPTION

The purpose of this course is to provide students with a thorough understanding of the design of reinforced concrete buildings/structures with particular emphasis on using the locally available steel rebars and concrete. Topics covered will include: Properties, Application and Testingof Plain Concrete, Basic Principles for Reinforced Concrete design, design of beams and slabs for flexure and shear; detailing of flexural and shear reinforcement; behaviour of reinforced concrete members under combined flexure and axial load; design of short columns; as well as detailing of steel for bond & development length and laps & splices, with focus on local practices.

Mapped SDGs:

| | |
|---|---|
| SDG-11<br>Sustainable Cities and Communities | 11.c ……… resilient buildings utilizing local materials local materials |

## COURSE LEARNING OUTCOMES

1. At the end of the course, the students will be able to:
2. ILLUSTRATE various properties of concrete.
3. DESIGN various structural reinforced concrete elements.
4. PRACTICE experiments on concrete for suitable use.

## COURSE OUTLINE

**1. Plain Concrete (Properties, Application and Testing)**

- Concrete constituent material and its mechanical properties
- Properties of freshly mixed concrete
- Durability aspects and factors contributing towards durability
- Creep and shrinkage of concrete
- Mix design and quality control
- Additives and admixtures
- Air entrainment
- Lightweight concrete
- Hot and cold weather concrete
- Precast concrete with special reference to cement concrete blocks

- Determination of fundamental structural properties of concrete and non-destructive testing (NDT)

**2. Reinforced Concrete (Basic Principles, Working Stress and Ultimate Strength Method)**

- Basic principles of reinforced concrete design and associated assumptions, behavior of reinforced concrete members in flexure, design philosophy, design codes, facto of safety and load factors, prevailing methods of design of reinforced concrete members.
- Working stress method, serviceability criteria and checks for deflection, crack width, and crack spacing, Importance of working stress method related to pre-stress.
- Ultimate strength method, analysis of prismatic and non-prismatic sections in flexure, compatibility-based analysis of sections and code requirements for flexure 177

**3. Structural Framing and Load Calculations of a Simple Structure for Gravity Design**

- Structural framing
- Load calculations, types of basic loads, service and factored load combinations
- Load distribution and calculations for slabs, beams, columns and footings

**4. Slab Analysis and Design for Gravity Loading**

- One-way solid and ribbed slabs
- Two-way solid slabs using coefficient method
- General discussion on other slab systems
- Design detailing

**5. Beam Analysis and Design for Gravity Loading**

- Flexure analysis and design of beams (singly, doubly, rectangle section, T/L sections, simple span, one end and both end continuous)
- Shear analysis and design of beams
- Design detailing

**6. Columns**

- Analysis of sections in pure compression,
- Design of short columns under pure compression and with eccentric loading,
- Design detailing
- Footings
- Isolated footings
- Structural design of simple rectangular footing and combined footing.
- Design detailing

**7. Steel Detailing (Bond, Anchorage & Development Length)**

- Design and detailing for bond, anchorage, development length, laps and splices

## OURSE OUTLINE (PRACTICALS)

**The following practicals may be carried out for the course.**

1. To study the compressive strength of concrete using cube and cylinder.
2. To prepare mix design for various strengths of concrete.
3. To find workability of concrete using slump cone method, compacting factor method, VeBe time method.
4. To study the effect of w/c ratio on the strength of concrete.
5. To study effect of aggregate/cement ratio of workability and compressive strength of concrete.
6. To determine the strength of concrete using core extraction and to discuss the results from control cylindrical samples.
7. To study the ultrasonic pulse velocity test and Schmidt hammer test on hardened
8. Concrete.
9. To study the behaviour of balanced reinforced, under-reinforced and over-reinforced concrete flexural members.
10. To study the behaviour of shear deficient flexural members. 178
11. To study the permeability of concrete samples with various mix ratio.

## SUGGESTED TEACHING & ASSESSMENT METHODS

**Suggested Teaching Methods**

Lecturing
Laboratory Demonstration
Written Assignments
Guest Speaker
Field Visits

**Suggested Assessment Methods Theorey**

One hour test(s)/Mid-semester Exam (s)
Quiz tests, Assignments, Project Reports/Term Paper/Presentations
Final Exam

**Suggested Assessment Methods Practicals**

Laboratory Participation
Laboratory Report/Manual
Laboratory Quiz /Viva Voce

## RECOMMENDED TEXT AND REFERENCE BOOKS


1. David Darwin, Charles Dolan, Arthur Nilson, (2016) Design of Concrete Structures. 15th (or latest) Edition., McGraw-Hill.

2. James K Wight and James G. Macgregor, Reinforced design: Mechanics and design, (2011), 6th (or latest) Edition.

3. M. Neville, (2011), Properties of Concrete, 5th edition, John Wiley.

4. Hassoun, M. N. & Al-Manaseer, A, (2015), Structural Concrete: Theory and Design, 7th (or latest) Edition.

5. Chu-Kia Wang, Charles G. Salmon, José A. Pincheira, (2017), Reinforced Concrete Design, Wiley; 8th (or latest) Edition.

6. N.V.Nayak & A.K.Jain, Handbook on Advanced Concrete Technology.

7. Concrete Structures, Part-I, 3rd (or latest) Edition, by Zahid Ahmed Siddiqi, 2016.

Available at:
http://www.pec.org.pk