Curriculum for

Naval Architecture

Bachelor of Engineering Program

2024

Pakistan Engineering Council
&
Higher Education Commission
Islamabad

CURRICULUM

FOR

NAVAL ARCHITECTURE ENGINEERING

Bachelor of Engineering Program

2024

Pakistan Engineering Council

&

Higher Education Commission

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 Competencies) 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 10th 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 Convener (ECRDC-Main)/ Member PEC Governing Body/ Rector NUST, Islamabad	Convener
2.	Engr. Prof. Dr. Altaf Mukati Vice President (Academics), SZABIST University, Karachi	Dy. Convener
3.	Engr. Prof. Dr. Bhawani Shankar Chowdhry, PEC Governing Body / Prof. Emeritus / Advisor MUET, Jamshoro	Member
4.	Engr. Prof. Dr. Shahid Khattak Convener, Elect Engg. & Allied Disciplines	Member
5.	Engr. Prof. Dr. Ehsan Ullah Khan Kakar Convener, Civil Engg. & Allied Disciplines	Member
6.	Engr. Prof. Dr. Syed Mushtaq Shah Convener, Mechanical Engg. & Allied Disciplines	Member
7.	Engr. Prof. Dr. Amanat Ali Bhatti Convener, Materials, Metallurgical, Mining, Petroleum and Gas Engg. & Allied Disciplines	Member

8.	Engr. Prof. Dr. Naveed Ramzan Convener, Chemical Engg. & Allied Disciplines	Member
9.	Engr. Dr. Muhammad Ashraf Convener, Agricultural Engg. & Allied Disciplines	Member
10.	Engr. Muhammad Raza Chohan Convener, Common to All (Non-Engg. Component)	Member
11.	Mr. Hidayatullah Kasi HEC Representative	Member
12.	Engr. Dr. Nasir Mahmood Khan	Secretary/ Registrar, PEC
13.	Engr. Niaz Ahmed Khaskheli Sr. Additional Registrar, EAD	Secretary ECRDC

2. ECRDC Agenda

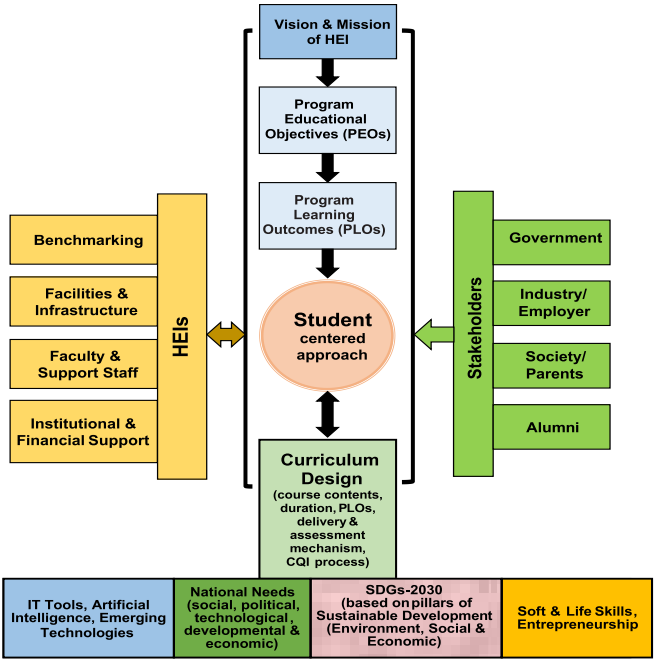
- The ECRDC is responsible to oversee the overall working of curriculum review and development for all engineering programs in terms of strategy, guidance & progress, and thereby submission to the relevant forum for adoption/ notification.

- Each Member of ECRDC will also work in the capacity of Convener for respective disciplines as mentioned against their names and as per their ToRs.

3. OBE Based Curriculum Development Framework

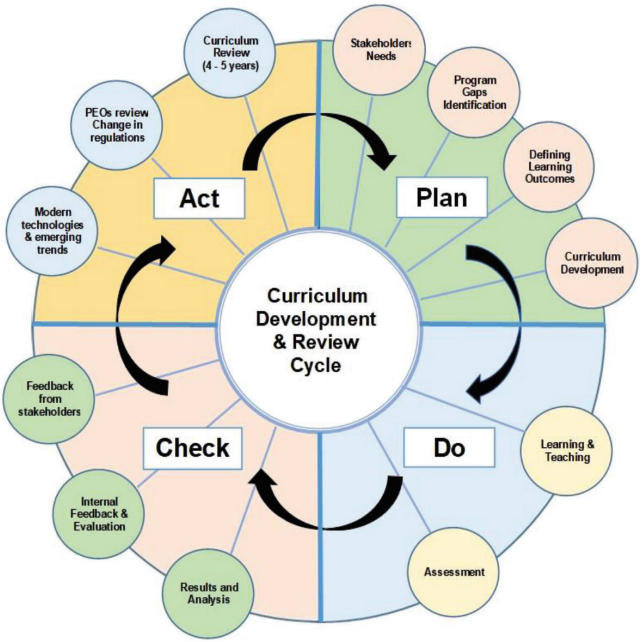
Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student's centered system which concerns what the students will know and be able to do as learning outcomes. The curriculum development 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 Mechanical & Allied Engineering Disciplines

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Mechanical and Allied Engineering Disciplines took up the task to review and update the curriculum for the Bachelor of Naval Architecture Engineering degree program. The subject Committee had conducted several meetings besides multiple sessions of Sub-Groups and the concluding meeting of ECRDC (Mechanical & Allied Engineering Disciplines) was conducted on 08-3-2024 at PEC Head Office Islamabad. The Committee consisted of following members:

1.	Engr. Prof. Dr. Syed Mushtaq Shah Member, PEC Governing Body/ Vice Chancellor, Mir Chakar Khan Rind University, Sibi	Convener
2.	Engr. Prof. Dr. Riffat Asim Pasha Member, PEC Governing Body/ Chairman, Mechanical Engineering Department, UET Taxila	Member
3.	Engr. Dr. Ajaz Bashir Janjua Member, PEC Governing Body/ Director-IDePRO, Pakistan Ordinance Factories, Wah Cantt.	Member
4.	Engr. Dr. Shaikh Zahoor Sarwar Member, PEC Governing Body/ Sr. Associate Professor, Bahria University, Islamabad	Member
5.	Engr. Prof. Dr. Mirza Jahanzaib Member, PEC Governing Body/ Chairman Industrial and Manufacturing Engineering, UET Taxila	Member
6.	Engr. Mohsin Ali Khan Member, PEC Governing Body/ Ex-GM, Pakistan Steel Mill, Karachi	Member
7.	Engr. Muhammad Nasir Khalily Member, PEC Governing Body/ Divisional Superintendent, Pakistan Railways, Karachi	Member

8.	Engr. Hidayatullah Kasi HEC Representative	Member
9.	Engr. Dr. Abdul Rehman Abassi Principal Engineer, KANUPP Karachi	Member
10.	Engr. Dr. Hamid Zaigham GM, KRL Islamabad	Co-opted Member
11.	Engr. Dr. M. A Irfan Mufti Professor, UET Peshawar	Co-opted Member
12.	Engr. Dr. Khalid Rehman Professor, GIKI Topi, Swabi	Co-opted Member
13.	Engr. Dr. Sahar Noor Professor, UET Peshawar	Co-opted Member
14.	Engr. Dr. Nadeem Ahmed Mufti Professor, UET Lahore	Co-opted Member
15.	Engr. Dr. Muhammad Shakaib Professor, NED-UET Karachi	Co-opted Member
16.	Engr. Dr. Salim-Ur-Rehman Professor, SUIT Peshawar	Co-opted Member
17.	Engr. Prof. Dr. M. Shahid Khalil Ex-Dean, UET Taxila	Co-opted Member
18.	Engr. Niaz Ahmed Sr. Additional Registrar/ HoD-EAD	Secretary ECRDCs
19.	Engr. Osaf Mahmood Malik Section Head (Curriculum & Development)	Additional Registrar-EAD
20.	Engr. Syed Haider Abbas Bokhari	Assistant Registrar-EAD
21.	Engr. Muhammad Junaid Khan	Assistant Registrar-EAD
22.	Mr. Muhammad Irfan	Office Superintendent-EAD

The working on curriculum development of Naval Architecture Engineering was initiated in 2023 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 Mechanical and Allied Engineering Disciplines.

Sub-Group Naval Architecture Engineering

1.	Engr. Prof. Dr. Muhammad Tufail, Pro Vice Chancellor, NED- UET, Karachi	Lead Sub-Group
2.	Engr. Dr. Nasir Mahmood Additional Director - MSD MTC HQ, NESCOM Complex, Islamabad	Member
3.	Engr. Dr. Shahid Mahmood DCM (Tech), MTC NESCOM, Islamabad	Member
4.	Engr. Cdre (R) Dr Muhammad Saeed Khalid CEO Bahria Classification Society	Member
6.	Engr. Dr. Zeeshan Riaz Dean, Naval Architecture Engineering PNEC (NUST), Karachi	Member
7.	Engr. Osaf Mahmood Malik Additional Registrar-EAD	Secretary Sub-Group

The ECRDC Mechanical and Allied Engineering Disciplines appreciated the extraordinary efforts and contribution of Engr. Prof. Dr. Syed Mushtaq Shah (Convener), Engr. Prof. Dr. Muhammad Tufail (Lead Sub-Group), Engr. Dr. Zeeshan Riaz (Member Sub-Group) & Engr. Osaf Mahmood Malik (Section Head Curriculum & Development) for compilation of course contents and proof reading of this curriculum booklet.

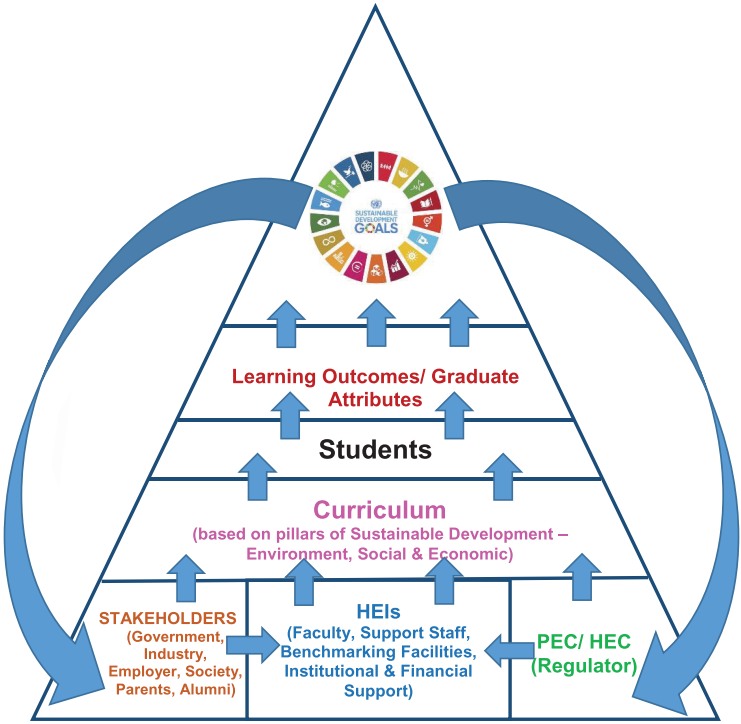
6. Agenda of ECRDC for Mechanical and Allied Engineering Disciplines

- 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. Syed Mushtaq Shah 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 development 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 attitude that the 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 (WK1-WK4).

- **PLO-2 Problem Analysis:** Identify, formulate, conduct research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (WK1-WK4).

- **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 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 the HEI'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.

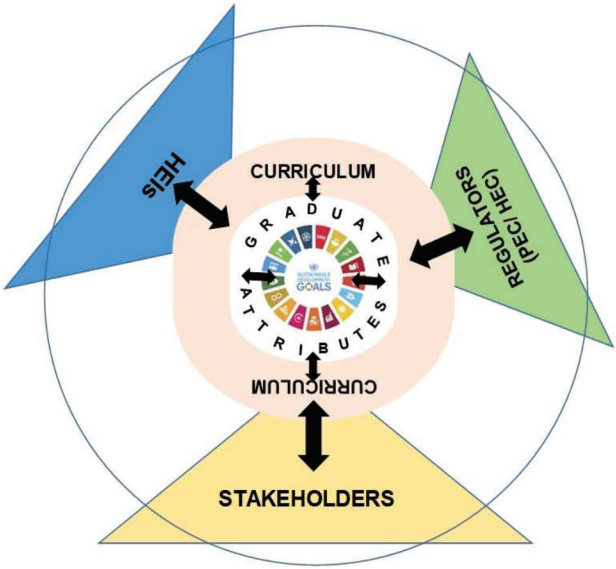


Figure 2: Consideration of UN SDGs in curriculum design

For undergraduate engineering program 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.

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

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

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

As an example, a non engineering course (Sociology for Engineers) has been mapped with the UN SDGs for the guidance purpose (Annexure B) and included in course outline section. 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 **Engineering Knowledge:** Breadth, depth and type of knowledge, both theoretical and practical	**EC-1** **Comprehend and apply universal knowledge,** & **EC-2** **Comprehend and apply local knowledge**	(WK-1, WK-2, WK-3 & WK-4) **WK-1** **Natural sciences** and awareness of relevant **social sciences** **WK-2** **Mathematics & computing** **WK-3** **Engineering fundamentals** **WK-4** **Engineering specialist knowledge**	SDG-9
PLO-2 **Problem Analysis**: Complexity of analysis	**EC-3** **Problem analysis**	(WK-1, WK-2, WK-3 & WK-4) **WK-1** **Natural sciences** and awareness of relevant **social sciences** **WK-2** **Mathematics & computing** **WK-3** **Engineering fundamentals** **WK-4** **Engineering specialist knowledge**	Selected SDGs from SDG - 1 to 17 (relevance as per curriculum)

PLO-3 **Design/ Development of Solutions:** Breadth and uniqueness of engineering problems i.e., the extent to which problems are original and to which solutions have not previously been identified or codified.	**EC-4** **Design and development of solutions**	**WK-5** **Engineering design and operations**	SDG-1, 2, 3, 6, 9, 10, 11, 12, 13, 14 (relevance as per curriculum)
PLO-4 **Investigation:** Breadth and depth of investigation andexperimentation	**EC-5** **Evaluation**	**WK-8** **Research literature**	SDG-9
PLO-5 **Tool Usage:** Level of understanding of the appropriateness of technologies andtools	**EC-3** **Problem analysis** **&** **EC-5** **Evaluation**	(WK-2 & WK-6) **WK-2** **Mathematics & computing** **&** **WK-6** **Engineering practice**	SDG-9
PLO-6 **The Engineer and the World:** Level of knowledge and responsibility for sustainable development	**EC-6** Protection of society **&** **EC-7** Legal, regulatory, and cultural	(WK-1, WK-5 & WK-7) **WK1** **Natural sciences** and awareness of relevant **social sciences** **WK-5** **Engineering design and operations** **& WK7** **Engineering in Society**	Selected SDGs from SDG - 1 to 17 (relevance as per curriculum)

PLO-7 **Ethics:** Understanding and level of practice	**EC-8** **Ethics: No differentiation in this characteristic**	**WK-9** **Ethics, inclusive behavior and conduct**	SDG- 5, 10, 16
PLO-8 **Individual and Collaborative Team work:** Role in and diversity of team	**EC-10** Communication and Collaboration	**WK-9** **Ethics, inclusive behavior and conduct**	SDG- 5, 10, 16
PLO-9 **Communication:** Level of communication according to type ofactivities performed	**EC-10** Communication and Collaboration	(WK-1 & WK-9) **WK-1** **Natural sciences and awareness of relevant social sciences** & **WK-9** **Ethics, inclusive behavior and conduct.**	SDG- 5, 10, 16
PLO-10 **Project Management and Finance:** Level of management required for differingtypes of activity	**EC-9** Manage engineering activities	(WK-2 & WK-5) **WK-2** **Mathematics & computing** & **WK-5** **Engineering** **design and operations**	SDG-9, 10
PLO-11 **Lifelong Learning:**Duration and manner	**EC-11** Continuing Professional Development (CPD) and lifelong learning **EC-12** Judgement **EC-13** Responsibility for decisions	**WK-8** **Research literature**	SDG-3, 4, 8, 9, 12, 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
  - o General Education for Engineering Discipline: Min. 38 Credit Hours
  - o Engineering Domain: Min. 72 Credit Hours
  - o FYDP/ Capstone Project: 06 Credit Hours
  - o Multidisciplinary Engineering Courses: Min. 06 Credit Hours
  - o HEIs have flexibility of 08-14 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 Naval Architecture Engineering, foundation, breadth, depth and multidisciplinary courses (including safety) so that different streams could be encouraged within each discipline, enabling students to undertake a range of Complex Problem Solving and Complex Engineering Activities. The students may select electives from any of the streams with guidelines from their respective advisors. The knowledge areas of Non-Engineering and Engineering domains have been broadly mapped with 11x PLOs and 9x WKs using the guiding framework of IEA version 4.0 in the following table:

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

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

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

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

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

*** PEC ECRDC designed courses

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

- Selection of internship 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.

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 Naval Architecture 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 Naval Architecture Engineering Curriculum

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Sub Area	Title of Course	Th	Lab	Total
General Education/ Non-Engineering Domain						
WK-1/ WK-5/ WK-7/ WK-9	**Humanities**	English	Functional English **	3	0	3
			Expository Writing **	3	0	3
		Culture	Ideology and Constitution of Pakistan **	2	0	2
			Islamic Studies / Ethics **	2	0	2
			Arts and Humanities Elective *	2	0	2
		Social Sciences	Social Science Elective ***	2	0	2
			Civics and Community Engagement **	2	0	2
	Management Sciences	Professional Practice	Entrepreneurship **	2	0	2
			Project Management ***	2	0	2
	Computer Sciences	Basic Computing	Applications of ICT **	2	1	3
WK-1/ WK-2	**Natural Sciences**	Math	Calculus and Analytical Geometry	3	0	3
			Linear Algebra & Differential Equations	3	0	3
			Multivariable Calculus and PDEs	3	0	3
			Numerical Analysis	2	1	3
		Physics	Applied Physics	2	1	3
		Natural Science/ Math Elective	Probability and Statistics	3	0	3
Total (General Education/ Non-Engineering Domain)				**38**	**3**	**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.

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Sub Area	Title of Course	Th	Lab	Total
Engineering Domain						
WK-2/ WK-4/ WK-5/ WK-6	Advanced Computer Science	ICT/AI/ Data Science/ Cyber Security	Fundamentals of Programming	0	1	1
			Applied AI and Machine Learning	2	1	3
WK-2/ WK-3	**Engineering Foundation**		Engineering Mechanics – I (Statics)	3	0	3
			Engineering Mechanics – II (Dynamics)	3	0	3
			Introduction to Ship Structure	3	0	3
			Fluid Mechanics	3	0	3
			Basic Naval Architecture	3	0	3
			Marine Material Sciences & Engineering	3	0	3
			Engineering Drawing & Graphics	0	2	2
			Workshop Practice	0	2	2
			Engineering Mechanics Lab	0	1	1
			Ship Structures Lab	0	1	1
WK-1/ WK-2/ WK-4	**Major Based Core (Breadth)**		Ship Structure – I	3	0	3
			Hydrodynamics	3	0	3
			Hydrodynamics Lab	0	1	1
			Ship Dynamics	3	0	3
			Ship Hydrostatics and Stability	3	0	3
			Ship Resistance and Propulsion	3	1	4
			Marine Engineering	3	0	3
			Ship Design and Production	2	0	2

WK-5/ WK-6	**Major Based Core (Depth)**		Ship Seakeeping	3	1	4
			Advanced Marine Vehicle	2	0	2
			Ship Structure – II	3	0	3
			Ship Maneuvering	3	1	4
			Finite Element Methods and Marine Application	2	1	3
			Technical Elective I	2	0	2
			Technical Elective II	2	0	2
			Technical Elective III	2	0	2
WK-1/ WK-2/ WK-3/ WK-4	**Multi-Disciplinary Engineering Courses**		MDE-I (Marine Electrical Engineering)	2	1	3
			MDE-II (Marine Control System)	2	1	3
WK-6/ WK-7/ WK-8	**Final Year Design Project (FYDP)/ Capstone**	Industrial/ Innovative/ Creative Project	FYDP (Part-I)	0	2	2
			FYDP (Part-II)	0	4	4
WK-6/ WK-7	**Industrial Training**	6 – 8 weeks Industrial Training (Non-Credit)		**Mandatory & Qualifying**		
Total (Engineering Domain)				**63**	**21**	**84**
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	**Innovative and Critical Thinking (under relevant courses):** - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open ended labs - Problem-based learning (PBL)					
WK-1/ WK-2/ WK-3/ WK-4	**Flexible Engineering/ Non-Engineering Courses**		Thermodynamics	3	0	3
			Health Safety & Environment	2	0	2
			Computer Aided Drawing	0	1	1
			Introduction to Marine Manufacturing Processes	1	1	2
			Marine Fabrication Method	2	1	3
Flexible Engineering/ Non-Engineering Courses				**8**	**3**	**11**
Total (Credit Hours)				**109**	**27**	**136**

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

12. Scheme of Studies for Bachelor of Naval Architecture Curriculum

1st Year				
First Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Calculus & Analytical Geometry	3	0	3
2	Functional English	3	0	3
3	Applications of ICT	2	1	3
4	Workshop Practice	0	2	2
5	Applied Physics (Natural Science Elective)	2	1	3
6	Engineering Mechanics-I (Statics)	3	0	3
Total		**13**	**4**	**17**

Second Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Fundamentals of Programming	0	1	1
2	Engineering Mechanics-II (Dynamics)	3	0	3
3	Linear Algebra and Differential Equations	3	0	3
4	Engineering Drawing and Graphics	0	2	2
5	Thermodynamics	3	0	3
6	Marine Materials Science and Engineering	3	0	3
7	Islamic Studies/ Ethics	2	0	2
	Total	**14**	**3**	**17**

2nd Year				
Third Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Introduction to Ship Structure	3	0	3
2	Fluid Mechanics	3	0	3
3	Multivariable Calculus and PDEs	3	0	3
4	Marine Electrical Engineering	2	1	3
5	Computer Aided Drawing	0	1	1
6	Ideology & Constitution of Pakistan	2	0	2
7	Arts and Humanities Electives *	2	0	2
8	Engineering Mechanics Lab	0	1	1
	Total	**15**	**03**	**18**

Fourth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Expository writing	3	0	3
2	Ship Structure 1	3	0	3
3	Ship Structure Lab	0	1	1
4	Basic Naval Architecture	3	0	3
5	Hydrodynamics	3	0	3
6	Hydrodynamics Lab	0	1	1
7	Health Safety & Environment	2	0	2
8	Introduction To Marine Manufacturing Processes	1	1	2
	Total	**15**	**03**	**18**

3rd Year				
Fifth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Social Sciences Elective **	2	0	2
2	Ship Hydrostatics and Stability	3	0	3
3	Ship Resistance and Propulsion	3	1	4
4	Marine Engineering	3	0	3
5	Ship Dynamics	3	0	3
6	Numerical Analysis	2	1	3
	Total	**16**	**2**	**18**

Sixth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Marine Control Systems	2	1	3
2	Probability and Statistics (Natural Science Elective)	3	0	3
3	Ship Structure-II	3	0	3
4	Ship Design and Production	2	0	2
5	Technical Elective-I ***	2	0	2
6	Ship Maneuvering	3	1	4
	Total	**15**	**2**	**17**

4th Year				
Seventh Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Finite Element Methods and Marine Applications	2	1	3
2	Ship Seakeeping	3	1	4
3	Technical Elective-II ***	2	0	2
4	Applied AI and Machine Learning	2	1	3
5	Entrepreneurship	2	0	2
6	Civic and Community Engagement	2	0	2
7	FYDP (Part-1)	0	2	2
	Total	**13**	**5**	**18**

Eighth Semester				
Sr. No	**Course Title**	**(Credit Hours)**		**Total Credit Hours**
		Theory	**Lab**	
1	Advanced Marine Vehicles	2	0	2
2	Technical Elective-III ***	2	0	2
3	Marine Fabrication Method	2	1	3
4	Project Management	2	0	2
5	FYDP (Part-2)	0	4	4
	Total	**8**	**5**	**13**

* List of Arts and Humanities Electives (2+0)	** List of Social Science Electives (2+0)
• Communication and Presentation Skills • Beginners Spanish • Elementary Arabic • Elementary French • Elementary Chinese • History • Philosophy • Professional Ethics • Any other relevant course/ language decided by the HEI as per requirement.	• Sociology for Engineers • Sociology • Social Psychology • Critical Thinking • Human Resource Management • Organizational Behavior • Engineering Law • Engineering Economics • Applied Psychology • Engineering Management • Financial Management • Marketing Management • Leadership and Personal Grooming • Any other relevant course decided by the HEI as per requirement.

* List of Arts and Humanities Electives (2+0)	** List of Social Sciences Electives (2+0)
• Communication and Presentation Skills • Beginners Spanish • Elementary Arabic • Elementary French • Elementary Chinese • History • Philosophy • Professional Ethics • Any other relevant course/ language decided by the HEI as per requirement.	• Sociology for Engineers • Sociology • Social Psychology • Critical Thinking • Human Resource Management • Organizational Behavior • Engineering Law • Engineering Economics • Applied Psychology • Engineering Management • Financial Management • Marketing Management • Leadership and Personal Grooming • Any other relevant course decided by the HEI as per requirement.

*** List of Technical Electives (2+0)	
• Submarine & Submersible Design • Design of Small Crafts • Design of Offshore Marine Structures • Port and Harbour Engineering • Coastal Engineering • Ocean Environmental Engineering • Underwater Work Systems • Ship Survey & Incident Investigation • Advanced Marine Structures • Design of Foundation for Marine Structures • Marine Production Tooling & Automation • Advanced Marine Manufacturing Processes	• Fuel Cell Technology For Marine Applications • Corrosion • Computational Fluid Dynamics and Marine Applications • Marine Environmental Issues • Submarine Structures • Ship Repair & Maintenance • UUV and Submarine Control & Maneuvering • Any other relevant course decided by the HEI as per requirement.

13. Program Specific Labs

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

a. Computing Lab
b. Ship Control & Dynamics Lab
c. Ship Hydrodynamics Lab
d. Ship Structure Lab
e. Materials Lab
f. Ship Design Lab
g. Marine Fabrication lab
h. Project Lab
i. Mechanical Workshop (Shared)
j. Engineering Drawing Hall (Shared)
k. Electrical Lab (Shared)

Note:

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

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

14. Course 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.

The Course Learning Outcomes (CLOs) are guidelines only, Higher Education Institutions (HEIs) have the flexibility to modify them based on the difficulty level of the course and the mapping with the specific Program Learning Outcomes (PLOs).

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.

14.1 Non- Engineering Domain

FUNCTIONAL ENGLISH

UGE Policy V1.1: General Education Course

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

1. Foundations of Functional English:

- Vocabulary building (contextual usage, synonyms, antonyms and idiomatic expressions)

- Communicative grammar (subject-verb-agreement, verb tenses, fragments, run-ons, modifiers, articles, word classes, etc.)
- Word formation (affixation, compounding, clipping, back formation, etc.)
- Sentence structure (simple, compound, complex and compound-complex)
- Sound production and pronunciation.

2. Comprehension and Analysis:

- Understanding purpose, audience and context.
- Contextual interpretation (tones, biases, stereotypes, assumptions, inferences, etc.).
- Reading strategies (skimming, scanning, SQ4R, critical reading, etc.).
- Active listening (overcoming listening barriers, focused listening, etc.).

3. Effective Communication:

- Principles of communication (clarity, coherence, conciseness, courteousness, correctness, etc.).
- Structuri ng 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. “English Grammar in Use” by Raymond Murphy.
4. “The Blue Book of Grammar and Punctuation” by Jane Straus.
5. “English for Specific Purposes: A Learning-Centered Approach” by Tom Hutchinson and Alan Waters.
6. “Cambridge English for Job-hunting” by Colm Downes.
7. “Practical English Usage” by Michael Swan.
8. “Reading Literature and Writing Argument” by Missy James and Alan P. Merickel.
9. “Improving Reading: Strategies, Resources, and Common Core Connections” by Jerry Johns and Susan Lenski.
10. “Comprehension: A Paradigm for Cognition” by Walter Kintsch.
11. “Communication Skills for Business Professionals” by J.P Verma and Meenakshi Raman.

EXPOSITORY WRITING
UGE Policy V1.1: General Education Course

Credits: 3+0
Pre-Requisite: Functional English

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

1. Introduction to Expository Writing:
- Understanding expository writing (definition, types, purpose and applications)
- Characteristics of effective expository writing (clarity, coherence and organization)
- Introduction to paragraph writing

2. The Writing Process:
- Pre-writing techniques (brainstorming, free-writing, mind-mapping, listing, questioning and outlining etc.)
- Drafting (three stage process of drafting techniques) Revising and editing (ensuring correct grammar, clarity, coherence, conciseness etc.)
- Proof reading (fine-tuning of the draft)
- Peer review and feedback (providing and receiving critique)

3. Essay Organization and Structure:

- Introduction and hook (engaging readers and introducing the topic)
- Thesis statement (crafting a clear and focused central idea)
- Body Paragraphs (topic sentences, supporting evidence and transitional devices)
- Conclusion (types of concluding paragraphs and leaving an impact)
- Ensuring cohesion and coherence (creating seamless connections between paragraphs)

4. Different Types of Expository Writing:

- Description
- Illustration
- Classification
- Cause and effect (exploring causal relationships and outcomes)
- Process analysis (explaining step-by-step procedures)
- Comparative analysis (analyzing similarities and differences)

5. Writing for Specific Purposes and Audiences:

- Different types of purposes (to inform, to analyze, to persuade, to entertain etc.)
- Writing for academic audiences (formality, objectivity, and academic conventions)
- Writing for public audiences (engaging, informative and persuasive language)
- Different tones and styles for specific purposes and audiences

6. Ethical Considerations:

- Ensuring original writing (finding credible sources, evaluating information etc.)
- Proper citation and referencing (APA, MLA, or other citation styles)
- Integrating quotes and evidences (quoting, paraphrasing, and summarizing)
- Avoiding plagiarism (ethical considerations and best practices)

PRACTICAL APPLICATIONS AND CAPSTONE PROJECT

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

ISLAMIC STUDIES
UGE Policy V1.1: General Education Course

Credits: 2+0
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 any course of at least the same or more credits in subjects such as religious studies, ethics, theology, comparative religion, Christian ethics, etc.

IDEOLOGY AND CONSTITUTION OF PAKISTAN
UGE Policy V1.1: General Education Course

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

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

- Address 1930, Congress Ministries 1937, Lahore Resolution 1940).
- Role of communalism and religious differences.

3. Introduction to the Constitution of Pakistan:

- Definition and importance of a constitution.
- Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949).
- Overview of constitutional developments in Pakistan.

4. Constitution and State Structure:

- Structure of Government (executive, legislature, and judiciary).
- Distribution of powers between federal and provincial governments.
- 18th Amendment and its impact on federalism.

5. Fundamental Rights, Principles of Policy and Responsibilities:

- Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28).
- Overview of Principles of Policy (Articles 29-40).
- Responsibilities of the Pakistani citizens (Article 5).

6. Constitutional Amendments:

- Procedures for amending the Constitution.
- Notable constitutional amendments and their implications.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

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

COMMUNICATION AND PRESENTATION SKILLS

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Communication and Presentation Skills" is designed to enhance students' abilities to communicate effectively in professional and academic settings. The course covers various aspects of communication including writing, reading, listening, and speaking skills. Students learn techniques for improving vocabulary, writing essays and letters, critical reading, active listening, verbal and non-verbal communication, and presentation strategies. Emphasis is placed on developing effective communication skills essential for job interviews and successful interactions in the workplace.

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.
5. Select and use audio-visual aids to enhance presentations.
6. Demonstrate effective communication skills in diverse contexts.

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 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: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Beginners Spanish" introduces students to the fundamentals of the Spanish language, focusing on basic communication skills and grammatical structures. The course covers essential vocabulary and expressions for greeting, introducing oneself and others, describing people and places, discussing daily activities, and expressing opinions. Additionally, students learn grammatical concepts such as verb conjugation, noun gender and number, and basic sentence structure to develop a foundation for further language proficiency.

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 INSTRUCTIONAL/ READING MATERIALS

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

ELEMENTARY ARABIC

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOME

"Elementary Arabic" provides students with a foundational understanding of the Arabic language, focusing on basic vocabulary, grammar, and conversational skills. The course covers essential greetings, introductions, and everyday life vocabulary, along with fundamental grammar concepts such as verb conjugation, noun and adjective formation, and sentence structure. Students will develop proficiency in speaking, listening, reading, and writing Arabic at an introductory level.

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 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: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Elementary French" offers students an introduction to the French language, covering essential vocabulary and grammatical structures for basic communication. Students will learn to engage in social interactions, discuss daily activities, express preferences, and describe personal experiences. The course emphasizes practical language skills necessary for everyday situations, such as greetings, shopping, and discussing food and leisure activities.

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 INSTRUCTIONAL/ READING MATERIALS

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

ELEMENTARY CHINESE

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Elementary Chinese" introduces students to the fundamentals of Mandarin Chinese, focusing on developing basic speaking, listening, reading, and writing skills. Students will learn Hànyǔ Pīnyīn for accurate pronunciation and recognize around 260 Chinese characters. The course covers essential grammar structures, vocabulary, and sentence patterns to enable students to communicate in simple everyday situations.

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 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: 2+0
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. Articulate the practical applications of studying history, recognizing its significance in informing decision-making, shaping identities, and contributing to a deeper comprehension of contemporary issues.
5. Explain the epistemological nature of history, including its methods of knowledge production and the challenges it faces.
6. 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

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. kins: University Press, 1992
5. Carr, E. H., What is History? Harmondsworth: Penguin, 1961
6. Cohn, Bernard. An Anthropologist among Historians and Other Essay, Oxford University Press, 1988
7. Collingwood, R. G. The Idea of History. Oxford: Oxford University Press, 1978.

8. Daniels, Studying History: How and Why, New Jersey, 1981.
9. Gertrude Himmalfarb. The New History and the Old, Cambridge: Harvard University Press, 1987
10. Govranski. History Meaning and Methods, USA, 1969
11. Hegel. Elements of the Philosophy of Right. Cambridge University Press, 1991

PHILOSOPHY

Credits: 2+0
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. Assess the scope and limits of knowledge within the realm of epistemology, considering their impact on the acquisition and application of knowledge in engineering contexts.
4. Examine different perspectives on knowledge within epistemology, relating these perspectives to engineering practices and the development of technological solutions.
5. Analyze the concept of induction, exploring its role in reasoning and its applications in the engineering field.
6. Compare and contrast the philosophical perspectives of rationalism and empiricism, considering their implications for the understanding of engineering phenomena.
7. Explore philosophical perspectives on meaning, considering how these perspectives influence the interpretation and significance of concepts within engineering contexts.

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Hales, S. D. (2021). This is philosophy: An introduction. John Wiley & Sons. Hospers, J. (2013). An introduction to philosophical analysis. Routledge.
2. Hurley, P. J. (2014). A concise introduction to logic. Cengage Learning.
3. Rachels, J., & Rachels, S. (1986). The elements of moral philosophy (p. 9). Philadelphia: Temple University Press.

4. Solomon, R. C., & Higgins, K. M. (2013). The big questions: A short introduction to philosophy. Cengage Learning.
5. Stewart, D. (2010). Fundamentals of Philosophy. 6th. Boston: Pearson

PROFESSIONAL ETHICS

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to grasp ideals and principles as they have been spelled out in a variety of traditional ethical systems and to apply these conceptual structures and guidelines to major problems and dilemmas of engineering practices in a corporate culture.

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.
3. Identify desirable personality traits for ethical behaviour.
4. Explain ethical livelihood in engineering, including halal earning.
5. Navigate moral dilemmas using ethical principles and frameworks.
6. Articulate engineers' rights and responsibilities (ip, whistleblowing, etc.).
7. Describe professional ethics in engineering societies and codes of conduct.
8. Analyze real-world ethical issues in engineering.
9. Apply critical thinking and problem-solving in ethical situations.
10. Discuss engineers' roles in social welfare, sustainability, and ethical practices.

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.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

CIVICS AND COMMUNITY ENGAGEMENT

UGE Policy V1.1: General Education Course

Credits: 2+0
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.

Service-Learning: Students can collaborate with a local nonprofit organization or community group. They can actively contribute by volunteering their time and skills to address a particular community need, such as tutoring, mentoring, or supporting vulnerable populations.

4. **Cultural Exchange Activities:** Students can organize a cultural exchange event that celebrates the diversity within the community. This could include food tastings, performances, and presentations that promote cross-cultural understanding.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

List of Social Sciences Electives (2+0)
• Sociology for Engineers
• Sociology
• Social Psychology
• Critical Thinking
• Human Resource Management
• Organizational Behavior
• Engineering Law
• Engineering Economics
• Applied Psychology
• Engineering Management
• Financial Management
• Marketing Management
• Leadership and Personal Grooming

SOCIOLOGY FOR ENGINEERS

Credits: 2+0
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**
  - o Extent to which development intends to sensitize societal and under privileged needs
  - o Gender inclusiveness and balance
  - o Special and Disadvantaged Community of the Area o Planning for community inclusiveness
  - o Societal Obligation of Engineers
- **Engineers, Society and Sustainability**

  Social System and Concept of Sustainable Development Technology and Development, Population Dynamics in Pakistan, Causes and Consequences of Unplanned Urbanization, Community Development, Programs in Pakistan, Community Organization & Engineering Projects, Population, Technological & Industrial expansion and Development with focus on social/human/ethical dimensions.

- **Industrial & Organizational Psychology**

  Interpersonal Relations, Interpersonal Behavior, Formation of Personal Attitudes, Language and Communication, Motivations and Emotions, Impact of Technology on human feelings and level of Sensitivity

- **Climate Change and Ecological Friendliness from Engineering Perspective**

  Ecological Processes, Ecosystem and Energy, Impact of Engineering Projects on Eco System & Human Ecology, Industrial & Environmental impact on Population & General Masses, Technological Intervention, Ecosystem and Physical Environment, Social Impact of Technology & Engineering Products & Services (Solid Waste Disposal, Pollution control etc.).

- **Social Approaches and Methodologies for Development Administration & Stakeholders Analysis:**

  All Phases of the Project (pre, post and execution) Structured, Focused Group, Stakeholder Consultative Dialogues etc. Dynamics of Social Change, Sociology of Change and Industrial Development, Social Change due to Technology Driven Economic Growth.

- **Case Studies of Different Development Projects in Social Context**
- **SIA (Social Impact Assessment):**

Base line and need-assessment, evaluation and impact assessment surveys of the development projects. Role of Engg & Technology for Creating Social Cohesiveness & Societal Integration. Technology Based change in Collective Behavior, Social Audit of Engineering Projects

- **Engineering Intervention for Social Stratification**

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

SUGGESTED 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.APhilosophy of Technology: FromTechnical Artefacts to Socio technical systems.
7. Mitcham,C.,andMunoz,D.2010.Humanitarian Engineering.Morganand ClaypoolPublishers. Riley,D.2008.Engineering and Social Justice Morgan and Claypool Publishers.
8. Bugliarello,G.1991.TheSocial Functions of Engineering: A Current Assessment, A Chapter in" Engineering as A Social Enterprise. Sociology

SOCIOLOGY

Credits: 2+0
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

COURSE CONTENT

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

Behavior, etc.

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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

SOCIAL PSYCHOLOGY

Credits: 2+0
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

1. Principles of sociology and psychology with emphasis on the individual and his/her reciprocal interaction with groups,
2. 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,
3. 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,
4. corruption and its control, thinking processes and decision making.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

CRITICAL THINKING

Credits: 2+0
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. Identify the steps involved in the critical thinking process.
4. Explain the importance of asking questions, actively listening, and challenging assumptions.
5. Describe common creative thinking techniques like brainstorming, mind mapping, and De Bono's thinking hats.
6. List and explain root cause analysis techniques like the 5 Whys and Ishikawa Diagram.
7. Identify and adapt your REACH profile to support critical thinking.
8. Describe strategies for effectively presenting recommendations to decision-makers and stakeholders.

COURSE CONTENT

- 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

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: 2+0
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).
2. Compare and contrast global and local HRM practices.
3. Explain basic principles of HRM from Islamic and indigenous perspectives.
4. Apply job analysis techniques, including HR planning, job description, and specification.
5. Differentiate between compensation and benefit packages and their management.
6. Explain staffing strategies, covering recruitment techniques, sources, and selection tests.
7. Identify key elements of employee relations.

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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

ORGANIZATIONAL BEHAVIOUR

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

"Organizational Behaviour" delves into understanding human behaviour within organizational settings, exploring topics such as structure, learning, stress management, motivation, leadership, group dynamics, and organizational culture. Through theoretical frameworks and practical applications, students gain insights into individual and group behaviours, organizational dynamics, and strategies for effective management.

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

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

ENGINEERING LAW

Credits: 2+0
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.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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

ENGINEERING ECONOMICS

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

COURSE OUTLINE

Engineering Economics

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

Interest Rate and Economic Equivalence

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

Understanding Money and Its Management

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

Present-Worth Analysis

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

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

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

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

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

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

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

Special Topics in Engineering Economics
- Replacement Decisions
- Capital Budgeting Decisions
- Economic Analysis in the Service Sector

RECOMMENDED TEXT AND REFERENCE BOOKS

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

APPLIED PSYCHOLOGY

Credit Hours: 2+0
Pre-Requisites: Nil

COURSE OUTLINE

This course provides an essential foundation in psychological principles tailored to the needs of engineering students. The course explores the scientific and historical contexts of psychology, the biological bases of behavior, and the intricate processes of sensation, perception, learning, memory, cognition, and language. It also covers intelligence, creativity, motivation, emotion, personality, and social psychology, with a focus on practical applications in engineering contexts. Through this course, students will gain insights into human behavior that enhance their professional and interpersonal skills in the field of mechatronics engineering.

COURSE OUTLINE

- Psychology: Scientific perspective
- Historical perspective
- Schools of psychology
- Methods of psychology
- Ethical issues
- Fields of psychology and their application

Biological Basis of Behavior

- Neuron and its function
- Central nervous system
- Peripheral nervous system
- Endocrine system

Sensation and Perception

- Senses: Vision, audition, smell, taste and kinesthetic
- Introduction to perception
- Gestalt principles
- Binocular and monocular cues
- Illusions and extra sensory perception

Learning

- Definition of learning
- Types of learning: Classical and operant conditioning
- Punishment and its effects
- Latent and observational learning

Memory

- Definition and types of memory
- Processes and techniques of improving memory
- Forgetting: Nature and causes

Cognition and Language
- Concept of cognition
- Problem solving
- Judgment and decision making
- Language development
- Language and cognition
- Language and culture

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

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

Personality
- Defining personality
- Theories of personality
- Personality assessment

Social Thinking and Social Influence
- Social facilitation
- Attribution theory
- Crowd behavior
- Conformity, Obedience
- Helping behavior

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Atkinson R. C., & Smith, E. E. (2000).Introduction to psychology (13th ed.). NY: Harcourt
2. Brace College Publishers.
3. Coon, D., &Mutterer, J. (2008).Introduction to psychology: Gateways to mind and behavior
4. (12th ed.). USA: Wadsworth Cengage Learning.
5. Fernald, L. D., & Fernald, P.S (2005).Introduction to psychology. USA; WMC Brown Publishers

ENGINEERING MANAGEMENT

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

COURSE OUTLINE

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

RECOMMENDED TEXT AND REFERENCE BOOKS

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

FINANCIAL MANAGEMENT

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

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

COURSE OUTLINE

Risk and return (Required rate)

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

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

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

Cash Operating / Conversion Cycle

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

Management of Marketable Securities

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

Receivables Management

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

Management of Receipts and Disbursements

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

Generic Current Assets' Management

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

Management of Current Liabilities

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

Leverage and Capital Structure

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

Payout Policy

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

Long-term Debt Management

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

RECOMMENDED

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

MARKETING MANAGEMENT

Credit Hours: 2+0
Pre-Requisites: Nil

DESCRIPTION

This course explores the essential marketing principles and strategies relevant to engineering professionals. This course provides an understanding of how marketing management has evolved and its impact on customer value. Topics include market segmentation, customer value creation, consumer behavior analysis, brand positioning, product and pricing strategies, value networks, marketing communications, and sales promotions. The course aims to equip students with the skills to apply marketing concepts to engineering products and services, fostering strong customer relationships and effective market positioning.

COURSE OUTLINE

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

- Managing Retailing, Wholesaling Why companies choose different marketing channels and how these marketing channels perform?
- Designing & Managing Integrated Marketing Communications Role of Marketing Communication. What are the guidelines for effective marketing communication mix?
- Managing Mass Communications: What steps are required in developing an advertising program? How should sales promotion decisions be made? What are the guidelines for effective brand-building events and experiences?
- Sales Promotions, Events Public Relations. Service Marketing Presentation

RECOMMENDED TEXT AND REFERENCE BOOKS

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

LEADERSHIP AND PERSONAL GROOMING

Credit: 2+0
Pre-Requisites: Nil

DESCRIPTION

This course is designed to develop essential leadership skills and personal development strategies tailored for future engineering professionals. The course covers fundamental leadership concepts, servant leadership, community development frameworks, social capital, community building practices, and professional ethical standards. Students will learn to assess community assets, build effective organizations, market their initiatives, mobilize resources, and measure progress in community and economic development projects.

COURSE OUTLINE

Fundamentals of Leadership and Servant Leadership

- What is leadership; Leadership Traits; Servant Leadership

Foundations of Community Development

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

Social Capital, Community Building and Community Development Practice

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

Community development assessment,

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

Building Powerful Community Organizations

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

Marketing your Organization

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

Mobilizing Resources: Raising Money

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

Measuring Progress

- Community development indicators, Best practices & Benchmarking

RECOMMENDED TEXT AND REFERENCE BOOKS

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

ENTREPRENEURSHIP

UGE Policy V1.1: General Education Course

Credits: 2+0
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. 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.

4. Opportunity Recognition and Idea Generation:

- Opportunity identification, evaluation and exploitation;
- Idea generation techniques for entrepreneurial ventures.

5. Marketing and Sales:

- Target market identification and segmentation;
- Four P's of Marketing;
- Developing a marketing strategy;
- Branding.

6. 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.)

7. Team Building for Startups:

- Characteristics and features of effective teams;
- Team building and effective leadership for startups

8. Regulatory Requirements to Establish Enterprises in Pakistan:

- Types of enterprises (e.g., sole proprietorship; partnership; private limited companies etc.);
- Intellectual property rights and protection;
- Regulatory requirements to register an enterprise in Pakistan, with special emphasis on export firms;
- Taxation and financial reporting obligation.

PRACTICAL REQUIREMENTS

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

PROJECT MANAGEMENT

Credits: 2+0
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 P rojects, 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 INSTRUCTIONAL/ READING MATERIALS

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

APPLICATIONS OF ICT

UGE Policy V1.1: General Education Course

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

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

COURSE LEARNING OUTCOMES

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

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

COURSE OUTLINE

1. Introduction to Information and Communication Technologies:

- Components of Information and Communication Technologies (basics of hardware, software, ICT platforms, networks, local and cloud data storage etc.).
- Scope of Information and Communication Technologies (use of ICT in education, business, governance, healthcare, digital media and entertainment, etc.).
- Emerging technologies and future trends.

2. Basic ICT Productivity Tools:

- Effective use of popular search engines (e.g., Google, Bing, etc.) to explore World Wide Web.
- Formal communication tools and etiquettes (Gmail, Microsoft Outlook, etc.).

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

3. ICT in Education:

- Working with learning management systems (Moodle, Canvas, Google Classrooms, etc.).
- Sources of online education courses (Coursera, edX, Udemy, Khan Academy, etc.).
- Interactive multimedia and virtual classrooms.

4. ICT in Health and Well-being:

- Health and fitness tracking devices and applications (Google Fit, Samsung Health, Apple Health, Xiaomi Mi Band, Runkeeper, etc.).
- Telemedicine and online health consultations (OLADOC, Sehat Kahani, Marham, etc.).

5. ICT in Personal Finance and Shopping:

- Online banking and financial management tools (JazzCash, Easypaisa, Zong PayMax, 1LINK and MNET, Keenu Wallet, etc.).
- E-commerce platforms (Daraz.pk, Telemart, Shophive, etc.)

6. Digital Citizenship and Online Etiquette:

- Digital identity and online reputation.
- Netiquette and respectful online communication.
- Cyberbullying and online harassment.

7. Ethical Considerations in Use of ICT Platforms and Tools:

- Intellectual property and copyright issues.
- Ensuring originality in content creation by avoiding plagiarism and unauthorized use of information sources.
- Content accuracy and integrity (ensuring that the content shared through ICT platforms is free from misinformation, fake news, and manipulation).

PRACTICAL REQUIREMENTS

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

1. Guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as word processing software (e.g., Microsoft Word), presentation software (e.g., Microsoft PowerPoint), spreadsheet software (e.g., Microsoft Excel) among such other tools students may be assigned practical tasks that require them to create documents, presentations and spreadsheets etc.
2. Assigning of tasks that involve creating, managing, and organizing files and folders on both local and cloud storage systems.. students will practice file naming conventions, creating directories, and using cloud storage solutions (e.g., Google Drive, OneDrive).
3. The use of online learning management systems (LMS) where students can access course materials, submit assignments, participate in discussion forums, and take quizzes or tests. This will provide students with the practical experience with online platforms commonly used in education and the workplace.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

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

CALCULUS AND ANALYTICAL GEOMETRY

Credit: 3+0
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

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

COURSE OUTLINE

- **Analytical Geometry:**
  a. Review of vectors, scalars and vector products.
  b. Three-dimensional coordinate system and equation of straight line and plane
- **Functions Limit and Continuity**
  a. Review of functions and graphs,
  b. Limits & Continuity,
  c. Techniques of Finding Limits,
  d. Discontinuity,
  e. Limits of Sine and Cosine and Exponential Functions
- **Differentiation:**
  a. Introduction to Derivatives
  b. Examples of Derivatives
  c. Derivative as Rate of Change
  d. Derivative's Rules
  e. Implicit Differentiation
  f. Higher order derivative
  g. Leibnitz Theorem
- **Applications of Derivatives:**
  a. Applications of Derivatives
  b. Monotonic functions
  c. Optimization problems
  d. Relative and Absolute extrema
  e. First and second derivative tests
  f. Point of inflection
  g. Concavity

h. Curvature
i. Indeterminate Forms and L' Hospital rule
j. Differentials

- **Integration:**

a. Integrals and Properties of Integrals
b. Techniques of Integration
c. Integration by Parts
d. Definite Integrals
e. Integration of Trigonometric
f. Exponential and Inverse Functions
g. Integration by Partial Fractions
h. Reduction Rules

- **Applications of Integration:**

a. Applications of Integration
b. Area under the curve
c. Area between curves
d. Solids of Revolution
e. Volume of Solids of revolution by disk
f. washer, Cylindrical shell & Cross Section Methods
g. Center of Pressure and Depth of Center of Pressure
h. Center of mass
i. Arc length

- **Improper Integrals:**

a. Improper Integral
b. Integrals and Singularities
c. Convergence of improper integrals

- **Infinite Sequence and Series:**

a. Sequence and Infinite Series
b. Convergence and Divergence of sequences and series
c. Positive Term Series
d. Integral Test
e. Basic Comparison Test
f. Limit Comparison Test
g. Ratio and Root tests
h. Alternating series
i. Absolute and Conditional Convergence

- **Power and Taylor Series:**

a. Power series
b. Maclaurin and Taylor Series and its Applications

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. George B. Thomas Jr., Maurice D. Weir, and Joel R. Hass, Thomas' Calculus, Pearson, USA, Latest edition.
2. Earl W. Swokowski, Michael Olinick, and Dennis Pence, Calculus, Latest edition.
3. Robert T. Smith and Roland B. Minton, Calculus, Latest edition.
4. James Stewart, Calculus: Early Transcendentals, Brooks/Cole, USA, Latest edition.

LINEAR ALGEBRA & DIFFERENTIAL EQUATIONS

Credit: 3+0
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

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

COURSE OUTLINE

Linear Algebra:

a. Basic Concepts. Matrix Addition. Scalar Multiplication Matrix Multiplication
b. Linear Systems of Equations. Gauss Elimination.
c. Solution of Linear Systems: Existence, Uniqueness, General Form
d. Inverse of a Matrix. Gauss-Jordan Elimination.
e. Vector Spaces, Sub Spaces and Linear Transformations
f. Linear dependence, linear independence, spanning set, basis
g. Eigenvalues and Eigenvectors

Differential Equations:

a. Separable Variables.
b. Homogeneous Equations.
c. Exact Equations and Integrating Factors.
d. Linear Equations.
e. Equations of Bernoulli, Ricatti and Clairaut.
f. Applications of Linear and Non-Linear First Order ODEs.
g. Linear Differential Equations of Higher Order: Preliminary Theory, Initial and Boundary Value Problems, Linear Dependence and Linear Independence.
h. Homogeneous Linear Equations with constant coefficients.
i. Non-Homogeneous Linear Equations with constant coefficients: Undetermined Coefficients, Variation of Parameters.
j. Non-Homogeneous Linear Equations with Variable Coefficients: Cauchy-Euler Equation.
k. Laplace Transform: Laplace Transform and Inverse Transform
l. Unit step function, Dirac delta function
m. Solution of 1st and higher order initial value problem using Laplace Transform

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Dennis G. Zill and Michael Cullen, Differential Equations, 3rd edition.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th edition.
3. Glyn James, Modern Engineering Mathematics, Latest edition.

MULTIVARIABLE CALCULUS AND PDE'S

Credit: 3+0
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

1. To develop a clear understanding of fundamental concepts of multivariable variable calculus
2. To describe of the concept of gradient, multiple integrals in rectangular, polar, cylindrical and spherical coordinates, directional derivatives, and optimization problems
3. To apply the concepts line integrals, surface integrals, volume integrals, Green's, Stokes', Gauss theorems to different engineering problems

COURSE OUTLINE

Linear Algebra

- Basic Concepts. Matrix Addition. Scalar Multiplication Matrix Multiplication
- Linear Systems of Equations. Gauss Elimination.
- Solution of Linear Systems: Existence, Uniqueness, General Form
- Inverse of a Matrix. Gauss-Jordan Elimination.
- Vector Spaces, Sub Spaces and Linear Transformations
- Linear dependence, linear independence, spanning set, basis
- Eigenvalues and Eigenvectors

First Order Ordinary Differential Equations

- Separable Variables.
- Homogeneous Equations.
- Exact Equations and Integrating Factors.
- Linear Equations.
- Equations of Bernoulli, Ricatti and Clairaut.
- Applications of Linear and Non-Linear First Order ODEs.

Linear Differential Equations of Higher Order

- Preliminary Theory.
- Initial and Boundary Value Problems.
- Linear Dependence and Linear Independence.
- Homogeneous Linear Equations with constant coefficients.

Non-Homogeneous Linear Equations with constant coefficients

- Undetermined Coefficients.
- Variation of Parameters.

Non-Homogeneous Linear Equations with Variable coefficients

- Cauchy-Euler Equation.

Laplace Transform

- Laplace Transform and Inverse Transform.
- Unit step function, Dirac delta function
- Solution of 1st and higher order initial value problem using Laplace Transform.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Dennis G. Zill and Michael Cullen, Differential Equations, Brooks/ Cole, 3rd edition.
2. E. Kreyszig, Advanced Engineering Mathematics, Wiley, 9th edition.
3. Glyn James, Modern Engineering Mathematics, Pearson, latest edition.

NUMERICAL ANALYSIS

Credit: 2+1
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

1. To comprehend different numerical techniques such as: error propagation, interpolation, differentiation, integration, eigenvalues and solution of algebraic and differential equations
2. To apply the numerical techniques to different linear and nonlinear engineering problems

COURSE OUTLINE

- **Error Analysis and Interpolation**

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

- **Numerical Differentiation and Integration**

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

- **Methods of solution a system of Linear Equations**

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

- **Iterative Methods for Linear and Nonlinear Equations**

  a. Numerical Solution of nonlinear equations: Bisection method, Newton's method, Secant method, Convergence analysis of these methods
  b. Newton's method for system of nonlinear equations
  c. Solution of system of linear equations by Jacobi, Gauss Seidel and SOR methods, Applications of these methods in engineering disciplines, Relevant case studies
- **Numerical Methods for IVPs and BVPs**
  a. Euler's method and its variations, Taylor's higher order methods, Error analysis, Consistency, stability and convergence
  b. Runge-Kutta methods of order 2, 3, and 4, Stiff ODEs, Consistency, stability and convergence
  c. Linear multistep methods, Numerical solution of system of ODEs
  d. Numerical solution of BVPs by Finite Difference Method
  e. Applications in engineering: Some relevant case studies
- **Numerical Methods for Computing Eigenvalues**
  a. Eigenvalues and Eigenvectors of matrix: power method,
  b. Inverse power method, Shifted inverse power method.
  c. Applications of eigenvalues in engineering disciplines.
- **Numerical Optimization**
  a. Unconstrained Optimization,
  b. Golden search ratio, Lagrange Multipliers,
  c. Method of steepest descent
  d. Applications of optimization in engineering disciplines

PRACTICAL REQUIREMENTS

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Richard L. Burden and J. Douglas Faires, Numerical Analysis, Publisher: Cengage Learning, Latest edition.
2. R.W. Hamming, Numerical Methods for Scientists and Engineers, Publisher: Dover Publications, Latest edition.
3. Steven C. Chapra and R. P. Canale, Numerical Methods for Engineers, Publisher: McGraw-Hill Education, Latest edition.

APPLIED PHYSICS

Credits: 2+1
Pre-Requisites: Nil

DESCRIPTION

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

COURSE OUTLINE

1. **Vectors:**

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

2. Mechanics:

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

3. Electrostatics And Magnetism:

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

4. Semiconductor Physics:

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

5. Waves And Oscillations:

Simple Harmonic Oscillator, Damped Harmonic Oscillation, Forced Oscillation and Resonance, Types of Wave and Superposition Principle, Wave Speed on a stretched string. Wave equation, Energy & Power of a Wave.

6. Optics And Lasers:

Huygens Principle, Two-slit interference, Single-Slit Diffraction, Resolving power of Optical Instruments. Principles for Laser action, Types of Laser, Applications of Laser.

7. Modern Physics:

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

PRACTICAL REQUIREMENTS

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

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Halliday, Resnick & Krane, Physics, Publisher: Wiley, 10th Edition.
2. Hugh D. Young and R.A. Freedman, University Physics, Publisher: Pearson, 12th Edition.
3. Serway, Jewett, Physics for Scientists and Engineers, Publisher: Cengage Learning, Latest edition.

PROBABILITY & STATISTICS

Credit: 3+0
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

1. To understand the basic concept of Statistics and Probability and their need in engineering.
2. To Describe properties and classifications of probability density functions, regression analysis and interval estimation
3. To Apply different probability and statistics techniques in engineering problems

COURSE OUTLINE

- **Basic Statistics,**
  a. Statistics, Branches of Statistics, Importance of statistics, population, sample, observation, variables, measurement of variable, Data, primary data, secondary data
- **Data Presentation,**
  a. Frequency distribution (grouped, ungrouped), stem and leaf display, histogram, frequency polygon, cumulative frequency polygon, Simple & Multiple Bar diagrams
- **Measure of central tendency,**
  a. Arithmetic Mean (A.M), Geometric Mean (G.M), Harmonic Mean (H.M), Quantiles (Median, Quartiles, Deciles, Percentiles), Mode, Applications of Averages
- **Measure of Dispersion,**
  a. Background, Range, Quartile deviation, Mean deviation, Variance, Standard deviation, Coefficient of variation, Moments, Moments ratios, Skewness, Kurtosis
  b. Applications in different Engineering Disciplines
- **Simple Regression, Correlation and Curve fitting**
  a. Introduction to regression theory, Simple linear regression line, Line fitting by least square methods, Coefficient of determination,
  b. Simple correlation, coefficient of correlation, fitting of a first and second degree curve, fitting of exponential and logarithmic Curves, related problems.
  c. Principle of least squares.

- **Probability and random variables,**
  a. Probability review, Laws of probability, Conditional probability, Bayesian theorem, independent, dependent events.
  b. Random variables, Discrete and Continuous random variables, Probability mass and density functions, Distribution functions, Mathematical expectation,
  c. Variance of random variable, Bivariate distribution, Joint probability distribution, Moment generating function
- **Probability Distributions,**
  a. Discrete distributions:
  b. Bernoulli distribution, Binomial, Geometric, Negative binomial, Hyper-geometric, Poisson distribution, Properties and application of these distributions.
  c. Continuous Distributions: Uniform Distribution, Exponential distribution, Normal distribution, Applications
- **Sampling and Sampling Distributions**
  a. Introduction, Population, Parameter & Statistic, Objects of sampling, Sampling distribution of Mean, Standard errors, Sampling & Non-Sampling Errors,
  b. Random Sampling, Sampling with & without replacement, Sequential Sampling, Central limit theorem.
  c. Applications in relevant engineering discipline
- **Statistical Inference and Testing of Hypothesis,**
  a. Introduction to inferential statistics, Estimation, hypothesis testing of population mean, proportion,
  b. Variance, Applications in Engineering

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Sher Muhammad Chaudhry, Introduction to Statistical Theory Part 1, Publisher: Ilmi Kitab Khana, Latest edition.
2. Erwin Kreyszig, Advanced Engineering Mathematics, Publisher: Wiley, Latest edition.
3. Antony Hayter, Probability and Statistics for Engineers and Scientists, Publisher: Duxbury Press, Latest edition.
4. Allan G. Bluman, Elementary Statistics, Publisher: McGraw-Hill Education.

14.2 Engineering Domain

FUNDAMENTALS OF PROGRAMMING

Credits: 0+1
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.

TEACHING METHODOLOGY (PROPOSED AS APPLICABLE):

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

COURSE CONTENT

1. Introduction to Computers:
2. Computer components and systems
3. Networks
4. Operating Systems 2. Programming:
5. Overview: What is programming? Computer configuration, algorithms, flowcharts, computer languages, generations and levels of programming languages, data and results, a typical IDE (Microsoft Visual C++ 6.0).
6. Data: Data types, data representation, identifiers, reserved words, variables, constants
7. Input and Output: Standard Library, output, address operator, input, string i/o, character i/o, escape sequences, assignment statement, type casting.
8. Operators: Arithmetic operators, operator precedence, associatively
9. Selection: Relational and logical operators, if, if/else, nested if's, conditional operator, conditional expressions, switch.
10. Repetition: While, do/while, for (; ;), break and continue statements.
11. Functions: Programmer defined functions, library functions, storage classes, scope, parameter passing, and recursion.

12. Arrays: Input and output of data, searching, sorting, array of characters, arrays as parameters.
13. Structures: Structure declaration, accessing structure members, arrays of structures, passing structures as function arguments.
14. Pointers: Address and indirection operators, pointer arithmetic, pointers and arrays, call by value and call by reference, dynamic memory allocation.
15. Files: Opening and closing files, reading and writing text files.
16. Introduction to Object Oriented Programming: Classes, instantiation, member function, data members, constructors, destructors, function overloading, default arguments.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Robert Lafore, Turbo C Programming for the PC, Publisher: Unknown.
2. Harvey M. Deitel and Paul J. Deitel, C++ How to Program, Publisher: Prentice Hall, Third Edition, 2000.
3. Robert Lafore, Object-Oriented Programming in C++, Publisher: Sams Publishing, Fourth Edition, 2001.
4. Richard P. Halpern, C for Yourself, Publisher: Oxford University Press, 1996.
5. B.J. Holmes, Programming with ANSI C, Publisher: DP Publications, 1996.

APPLIED AI AND MACHINE LEARNING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course aims to enhance expertise in Applied AI and Machine Learning through a comprehensive course covering fundamental concepts like SVM, SoftMax loss, and Stochastic Gradient Descent, while delving into advanced topics including Computer Vision, Deep Learning, and ML Explainability for a well-rounded understanding of cutting-edge technologies

COURSE LEARNING OUTCOMES

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

1. Fundamental Understanding of Machine Learning Techniques such as SoftMax loss, and Stochastic Gradient Descent Identify uses of various ICT platforms and tools for different purposes.
2. Construct neural network architectures for specific tasks, while also understanding the nuances of enhancing model performance through various techniques Understand the ethical and legal considerations in use of ICT platforms and tools
3. Explain and interpret machine learning models effectively.

COURSE CONTENT

1. Introduction to Machine Learning
2. SVM and Softmax loss
3. Stochastic Gradient Descent
4. Computer Vision Basics
5. Image analysis
6. Feature extraction and processing
7. Shallow neural network
8. Introduction to Deep learning
9. Backpropagation in neural networks
10. Dropout, Batch normalization and optimization
11. ML Explainability

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Tom Mitchell, Machine Learning, Publisher: McGraw Hill, Latest Available Edition.
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Publisher: Springer, Latest Available Edition.
3. Goodfellow, Ian, et al., Deep Learning, Publisher: MIT Press, Latest Available Edition.

4. Google AI Kaggle Learn online course.
5. CS229 lecture note (Available at: https://cs229.stanford.edu/main_notes.pdf).

ENGINEERING MECHANICS (STATICS) –I

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Statics is the study of methods for quantifying the forces between bodies. Forces are responsible for maintaining balance and causing motion of bodies, or changes in their shape. Motion and changes in shape are critical to the functionality of artifacts in the man-made world and to phenomena in the natural world. Statics is an essential prerequisite for many branches of engineering, such as mechanical, civil, aeronautical, and bioengineering, which address the various consequences of forces

COURSE LEARNING OUTCOMES

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

1. Use equation of equilibrium to determine forces, moments and couples in 2D/3D coordinate system.
2. Implement equations of equilibrium to solve problems related to rigid-bodies in equilibrium.
3. Analyze the forces acting on the members of trusses, frames and machines.

COURSE CONTENT

1. Revision of Basic concepts: Statics and Dynamics. Concepts of Force, Particle, Rigid Body, Concentrated Force, Laws of Motion, Newton's law of Gravitational Attraction. Classification of Forces. Principle of Transmissibility
2. Vector Description of Forces and Moments: Force Vectors: Revision of basic vector operations e.g. vectors, addition, subtraction, multiplication & division of vectors by scalar. Resolution of Vectors, Parallelogram Law.
3. Classification and equivalence of force system: Addition of a system of Coplanar Forces. Cartesian Vectors. Concepts of Cartesian vectors applied to Concurrent force systems. Position vectors. Force vector directed along a line. Dot and Cross products, Resultant of a Force and Couple System. Reduction of a Force and Couple System, simplifications to a single resultant force, concurrent force, coplanar and parallel force systems. Reduction of forces and couple moment systems to a Wrench. Reduction of a simple distributed loading.
4. Two and three- dimensional equilibrium of particles: Condition for the equilibrium of a Particle, The Free Body diagram. Coplanar Force Systems using Scalar notation. Three-dimensional Force Systems,

Equations of Equilibrium. Two and Three-force members and free body diagrams.

5. Two and three-dimensional equilibrium of rigid bodies: Conditions for Rigid Body equilibrium. Equilibrium in two dimensions, free body diagram, support reactions, Equations of Equilibrium. Two and Three-force members, free body diagrams, Equilibrium in three dimensions, scalar and vector equations of equilibrium, and constraints for a Rigid Body.
6. Elements of Structure: Simple Trusses-basic definition, assumption for design. The Method of Joints,Zero-Force Members. Method of Sections. Space Trusses, Frames, Machines, Beams.
7. Friction: Theory of Friction. Classifications of Friction. Friction Laws. Static and Kinetic coefficients of friction. Angle of Repose. Friction applications-Wedges.
8. Virtual Work: Definition of work and virtual work, Principle of virtual work for Particles, rigid bodies, and systems of connected rigid bodies, Conservative forces, Potential energy and criterion for equilibrium, Stability of equilibrium.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. R. C. Hibbeler, Engineering Mechanics – Statics, Publisher: Pearson,
2. W. F. Riley and L. D. Sturges, Engineering Mechanics – Statics, Publisher: Wiley,
3. Ferdinand L. Singer, Engineering Mechanics - Statics & Dynamics, Publisher: Harper & Row,

ENGINEERING MECHANICS (DYNAMICS) –II

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

To develop in students an insight to realize engineering applications associated with dynamics and motion of components in solid bodies seen in daily life.

COURSE LEARNING OUTCOMES

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

1. Describe key concepts related to kinematics/ kinetics of particles in different coordinate systems.
2. Solve problems related to kinematics/ kinetics of particles.
3. Compute various motion parameters related to the kinematics/ Kinetics of rigid bodies under translation and rotation / general plane motion.
4. Analyze and solve the problems related to kinematics/ kinetics of rigid bodies using different principles and techniques for their solution .

COURSE CONTENT

1. Introduction to subject and Basic Concepts
2. Kinematics of Particles
   a. Rectilinear Motion
   b. Plane Curvilinear Motion
   c. Space Curvilinear Motion
   d. Motion Relative to Trans Axes
   e. Constrained Motion of Connected Particles
3. Kinetics of Particles
   a. Second Law & Equation of Motion
   b. Work and Energy
   c. Linear Impulse and Momentum
   d. Impact
   e. Angular Momentum
4. Kinematics of Rigid Bodies
   a. Plane Motion
   b. Relative Velocity
   c. Relative Acceleration
5. Kinetics of Rigid Bodies
   a. Kinetics of Rigid Bodies

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. J.L. Meriam, L.G. Kraige, Engineering Mechanics (Dynamics), Publisher: John Wiley & Sons Inc.
2. Beer & Johnston, Vector Mechanics for Engineers: Statics & Dynamics, Publisher: McGraw Hill.
3. R.C. Hibbeler, Engineering Mechanics (Dynamics), Publisher: Prentice Hall, 13th Edition.
4. Anthony M. Bedford, Wallace Fowler, Engineering Mechanics (Dynamics), Publisher: Prentice Hall.
5. E. Nelson, Engineering Mechanics: Statics, Publisher: Schaum's Outline Series, New York.

INTRODUCTION TO SHIP STRUCTURE

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Introduction of fundamental concepts of solid mechanics and familiarization with the basic methods of analysis, and provide understanding of component behavior under load while considering material response through typical structural engineering examples.

COURSE LEARNING OUTCOMES

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

1. Explain nature of stress in a loaded structural member with cognizance of internal profiles near and far from the contacting load applied
2. Calculate the amount of forces and moments applied on the member with its physical response in the shape of deformations, deflections, twists and extension/reduction of dimensions
3. Examine the relationship of critical mechanical properties with the service performance of a part/component

COURSE CONTENT

1. Introduction to Stress and Strain, Normal, Shear and Bearing
2. Axially Loaded Members, Compound Bars
3. Thermal stresses
4. Mechanical properties of Materials from Mechanical Testing, relationship of various properties
5. Torsion theory, Shear stress and Shear strain in shafts
6. Power Transmission in shafts
7. Pure Bending, Bending of Composite Beams (e.g. Reinforced Concrete beams)
8. Shear & Bending Moment Diagrams, with use of singularity function
9. Unsymmetrical bending of beams
10. Stress on oblique places, Transformation of 3D stress system, use of Mohr's Stress Circle
11. Deflection of Beams, equation of the elastic curve
12. Double Integration, Superposition and McCauley's approach to find deflection and slope in beams

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. M.F. Ashby, D.R.H. Jones, Engineering Materials-I, Publisher: Unknown, Second Edition.
2. P.P. Benham, R.J. Crawford, Mechanics of Engineering Materials, Publisher: Unknown.
3. R.C. Hibbeler, Mechanics of Materials, Publisher: Unknown, Eighth Edition.
4. J.M. Gere, B.J. Goodno, Mechanics of Materials, Publisher: Unknown, Eighth Edition.
5. E.J. Hearn, Mechanics of Materials (2 Volumes), Publisher: Unknown, Third Edition.

FLUID MECHANICS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

To develop in the students an ability to apply principles of fluid mechanics and dimensional analysis to pipe flows and other one dimensional fluid flow problems.

COURSE LEARNING OUTCOMES

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

1. Use the Bernoulli equation to solve simple flow problems
2. Differentiate between the laminar and turbulent flow characteristics
3. Apply conservation of mass and energy and Newton's second law of motion to the contents of a finite control volume.

COURSE CONTENT

1. Fluid Properties

a. Definition of fluid and its classification
b. Concept of continuum.
c. Properties of the fluid.

2. Fluid Statics

a. Concept of Pressure and basic equations for compressible and incompressible
b. Pressure measurements and devices.
c. Hydrostatics forces on plane and curved surfaces.
d. Buoyancy and Stability.
e. Pressure variation in fluid with rigid body motion.

3. Fluid Kinematics

a. Flow characteristics, Descriptions of Velocity, and acceleration field (Streamlines, streak lines and path lines).
b. Control volume and representation of system.
c. Deriving Reynolds transport theorem(RTT).

4. Fluid Dynamics

a. Application of Newton's 2nd law in fluids.
b. Total, stagnation and dynamic pressure.
c. Deriving Bernoulli equation and its applications.

6. Integral Analysis of Fluid Flow

a. Deriving continuity equation using RTT.
b. Deriving linear momentum equation using RTT.
c. Deriving moment of momentum equation using RTT.
d. Dimensional Analysis, Similitude and Modeling
e. Dimensional analysis
f. Buckingham Pi theorem and determination of Pi terms

7. Flow in Pipes

a. Characteristics of pipe flow laminar and turbulent.
b. Calculating friction factor and wall shear stresses.
c. Solving pipe flow network problems

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Munson, Young, Okiishi HT John, Fundamentals of Fluid Mechanics, Publisher: John Wiley & Sons.
2. Philip J. Pritchard, John C. Leylegian, Fox and McDonald's Introduction to Fluid Mechanics, Publisher: John Wiley & Sons.
3. Frank M. White, Fluid Mechanics, Publisher: McGraw Hill.

BASIC NAVAL ARCHITECTURE

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

This course will provide students with an introduction to the fundamental properties of floating bodies, covering those areas conventionally treated by hydrostatic methods and will provide students with an early insight into the range of tasks involved in the design, construction, management and operation of marine vehicles and an awareness of the engineer's responsibility to society.

COURSE LEARNING OUTCOMES

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

1. Describe the basic principles of equilibrium of floating bodies
2. Use basic numerical methods, such as Simpson's and trapezium rules and interpolation techniques, to formulate and obtain hydrostatic properties of hull forms
3. Understand the different types of marine vehicles and identify characteristics influencing their design.

COURSE CONTENT

- Introduction to Naval Architecture, What naval architecture involves, How it developed, The roles of the naval architect. The ship design process and basic terms related to ship hull form and geometry. Read and interpret a ship's lines drawing and table of offsets, Definitions, nomenclature and notation, Units, Approximate integration, Simple calculations.
- Archimedes' Principle and utilize it to determine the waterline at which a ship will float. Calculate the volume and center of volume for a ship-like shape given a set of ship's lines and/ or table of offsets.
- Concept of initial static equilibrium when applied to a floating body. Describe the effects of the vertical position of the center of gravity and a ship's form (shape) on the initial stability. Calculate the metacentric radius and metacentric height of a ship given the lines drawing and/or table of offsets. Be able to determine the changes in drafts as a result of loading changes/ weight changes.
- Basic principle of ship structural design and rule of thumb for structural weight and cost fractions.
- Principles of ship sea keeping and maneuvering and their importance.
- Use MS Excel to calculate sectional areas, waterplane areas, underwater volume, LCF, LCB and KB using a developed table of offsets for a simple design. Develop a ship's lines drawing, general arrangements drawing and midship's construction drawing for a simple design.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. E.C. Tupper, K.J. Rawson, Basic Ship Theory, Combined Volume.
2. Edward V. Lewis, Principles of Naval Architecture Vol I - Stability And Strength, Publisher: The Society of Naval Architects and Marine Engineers, 1988.

MARINE MATERIAL SCIENCE AND ENGINEERING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

To familiarize students with different categories of engineering materials, their possible application, microstructure of engineering materials and properties associated with these microstructures

COURSE LEARNING OUTCOMES

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

1. Explain different material types, their properties and applications
2. Analyze the effect of different methods/processes on the microstructure, material properties and end product.
3. Select engineering materials for a given applications on the basis of material properties
4. Explain the effect of materials on the environment

COURSE CONTENT

- Introduction to Materials Science and Engineering
- Atomic Bonding
- Structure of Crystalline Solids
- Imperfections in Solids
- Phase Diagrams
- Phase Transformation and Development of Microstructures
- Applications and Processing of Metallic Materials
- Structure, Properties and Applications of Polymer Materials
- Composite Materials (Importance, Classification, Phases Present, Influence of direction, Composite Strength, Manufacturing Processes).
- Corrosion and degradation of Materials

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. William Callister, Introduction to Materials.
2. J.T. Black, Ronald A. Kohser, De Garmo's Materials and Processes in Manufacturing, Publisher: Wiley.
3. Roy A. Lindberg, Processes and Materials of Manufacturing.

ENGINEERING DRAWING & GRAPHICS

Credits: 0+2
Pre-Requisite: Nil

DESCRIPTION

To inculcate in students the ability to comprehend the science of Engineering Drawing so that they are able to convey their creative ideas effectively.

COURSE LEARNING OUTCOMES

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

1. Apply principles of engineering visualization and projection theory to prepare engineering drawings, using conventional and modern drawing tools
2. Draw orthographic projection, sectional views, and isometric views of different mechanical parts.

COURSE CONTENT

1. Orthographic Projection: Principle and Methods of projection, Orthographic projection, Planes of projection, First and Third-angle projection, Reference line
2. Projection of Points: A point is situated in the first, second, third and fourth quadrant.
3. Projection of Straight Lines: Line parallel and perpendicular to one or both the planes, Line contained by one or both the planes, Projections of lines inclined to both the planes, True length of a straight line and its inclinations, Methods of determining traces of a line.
4. Projection of Planes (2D): Types and Traces of planes, Projections of planes, Projections of oblique planes
5. Projections on Auxiliary Planes (2D): Types of auxiliary planes and views, Projection of a point on an auxiliary plane, Projections of lines and planes.
6. Projections of Solids (3D): Types of solids and their projections, Projections of solids with axes inclined.
7. Section of Solids (3D): Section of planes, prisms, pyramids, cylinders, cones, spheres, Methods of development, Triangulation development, Developments of lateral surfaces of right solids
8. Isometric Projections (3D): Isometric axes, lines, planes, and scale, Isometric drawing or isometric view, Isometric drawing of planes or plane figures, prisms and pyramids, cylinders, cones and sphere

9. Introduction: Introduction to Engineering Drawing, I. S. specification for preparation of drawings, Use of drawing instruments and materials, Basic Tools, Lines: Types, configuration and application, Selection of line thickness.
10. Lettering, Numbering and Dimensioning: Vertical and inclined single stroke letters, Lettering types and rules, Dimension lines, projection lines, leaders or pointer lines, Arrow heads, Dimensioning,
11. Geometric Construction: Drawing simple geometric objects (polygon, pentagon and hexagons etc).
12. Orthographic Projections of different Solids
13. Orthographic Projections of Machine Elements: Rivets, Nut and bolts, Different kinds of threads, Lap and butt joints, Flange couplings, Journal bearing, Open bearing, Footstep bearing, Crankshaft, Bearings
14. Practical: Select a machine and study its operation and machine elements detail, Draw the 3D model of the machine and draw 2D drawings,

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. N.D Bhatt, Engineering Drawing and Graphics.
2. B. Wiebe, M. Mohler, Technical Graphics Communication, Publisher: McGraw-Hill.
3. Abbot, Practical Geometry & Engineering Graphics.
4. Craft, Meyers & Boyer, Engineering Graphics.
5. G.R. Bertoline, E.N. Wiebe, Technical Graphics Communication, Publisher: McGraw-Hill.
6. D.F. Rogers, J.A. Adams, Mathematical Elements for Computer Graphics, Publisher: McGraw-Hill.
7. A.C Parkinson, A First Year Engineering Drawing.

WORKSHOP PRACTICE

Credits: 0+2
Pre-Requisite: Nil

DESCRIPTION

The course aims to provide students with comprehensive knowledge and practical skills in various workshop technologies, including manufacturing processes, measuring techniques, machining practices, forging, foundry work, electrical systems, welding, sheet metal work, and surface treatment, preparing them for real-world engineering applications through hands-on experiences and case studies

COURSE LEARNING OUTCOMES

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

1. Practice the basics of workshop safety, good housekeeping and safe working habits
2. Produce wooden and metal parts using bench fitting and carpentry tools and measuring instruments.
3. Produce welding joints.

COURSE CONTENT

1. Introduction to Workshop Technology
   a. Definitions and Terminologies
   b. Process of Manufacturing
   c. Industrial Safety
   d. Industrial Materials
   e. Manufacturing Standards
   f. Quality Control

2. Measuring Techniques
   a. Measuring System / Standards
   b. Manufacturing Metrology
   c. Limits, Fits Allowances and Tolerances
   d. Measuring Instruments and their Uses

3. Bench Fitting Practice
   a. Fib and Tolerances
   b. Filling Work, Jigs and Fixtures,
   c. Taps and Die work
   d. Drilling and Grinding,
   e. Marking and Punching

4. Machining Practice (Lathe)
   a. Types of Lathe Machines and Operations
   b. Cutting Tools, Accessories and Attachments

c. Parts of lathe machines
d. Safety Precautions

5. Machining Practice (Milling)
a. Types of milling Machines and Operations
b. Cutting Tools, Accessories and Attachments
c. Parts of Milling Machine
d. Safety Precautions

6. Pattern Making / Wood Work
a. Introduction to wood and Classification
b. Seasoning of Wood
c. Engg application of wood
d. Properties of wood and wood joints
e. Pattern Making, Wood Defects
f. Wood Working Tools and Machines

7. Forging Work
a. Forging Tools
b. Hot and Cold Forging
c. Properties and Crystals, Structure of Metals
d. Forging Types / Operations
e. Safety Precautions

8. Foundry Work
a. Introduction to Foundry
b. Different methods of casting including latest techniques
c. Different types of furnaces
d. Mold and Die casting
e. Casting defects
f. Safety Precautions

9. Electrical Technology
a. Basic Electrical Technology
b. Power Supply Circuits,
c. Types of Cables and Insulators
d. Electrical Tools and Instruments
e. Basic Fault Diagnosis in Circuits
f. Electrical Devices
g. Electrical Shock prevention and treatment
h. Electrical Safety Precautions

10. Welding Technology
a. Introduction to Welding Theory
b. Types of Welding, Welding Joints
c. ARC Welding Techniques
d. Gas Welding Techniques
e. Safety Precautions

11. Sheet Metal Work / Fabrication

a. Form and Size of Sheet Metals h. Shearing and Bending of Process
b. Sheet Development and Marking
a. Sheet Metal Joints Properties of Metals related to Sheet Forming
b. Safety Precautions

12. Surface Treatment and Paint Work

a. Electroplating Processes
b. Electroplating Techniques
c. Preparation of Work
d. Piece (Degreasing and Pickling etc)
e. Solution preparation for plating and their environmental issues
f. Paints and application
g. Primers and Solvents

13. **Term Project + Case Study + Presentations**

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. John R. Walker, Modern Metal Working, Edition: Latest Available Edition.
2. S.F. Krar, A.R. Gill, Peter Smid, Introduction to Technology of Machine Tools, Edition: Latest Available Edition.
3. Engr. Muhammad Naweed Hassan, Introduction to Workshop Technology.
4. WA. J Chapman, Workshop Practice.
5. Althouse, Welding Technology.

ENGINEERING MECHANICS LAB

Credits: 0+1
Pre-Requisite: Nil

DESCRIPTION

To supplement the theoretical knowledge of Engineering Mechanics (Statics and Dynamics) with laboratory experiments

COURSE LEARNING OUTCOMES

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

1. Conduct Engineering Mechanics (Statics & Dynamics) related experiments and analyze/interpret experimental data.
2. Perform experiments of Engineering Mechanics (Statics & Dynamics) in individual capacity as well as in groups as per the provided guidelines.
3. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

COURSE CONTENT

1. Understanding of Laboratory Safety Instructions and General Rules of the Laboratory
2. Determine the theoretical and experimental time period and natural frequency of vibrations of a simple pendulum
3. Determine Maximum energy of a flywheel and maximum velocity of the descending mass
4. Determine the moment of inertia of a flywheel
5. Determine the coefficient of friction between various materials on steel plane (Flat Surface)
6. Determine the coefficient of friction of various materials on a steel plane by changing the inclination angle
7. Determine Limiting Coefficient of Friction by using Brake Slip Friction Apparatus
8. Calculate the time period of Compound pendulum and compare it with the theoretical values
9. Determine the modulus of elasticity of a cantilever beam
10. Show the Static and Dynamic Balance of an object

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

- Lab Manual

SHIP STRUCTURE LAB

Credits: 0+1
Pre-Requisite: Nil

DESCRIPTION

To supplement the theoretical knowledge of mechanics of materials with laboratory experiments.

COURSE LEARNING OUTCOMES

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

1. Analyze experimental data as per concepts of ship structure
2. Perform experiments in individual capacity as well as in groups as per the provided guidelines
3. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

COURSE CONTENT

1. Understanding of Laboratory Safety Instructions and General Rules
2. To determine the Rockwell Hardness of the Metal Samples
3. To determine the impact strength of metal sample from CHARPY and IZOD impact test machine
4. To determine the Torque and angle of Twist of the given solid metal shaft through Torsion Testing Machine
5. To determine the Ultimate Tensile Strength of the metal sample from Universal Testing Machine and find the Yield Strength and percentage elongation
6. To study the conventional heat treatment procedure used to alter the properties of steel
7. To find the shear stress, shear strain and shear Modulus of Rubber Block
8. To investigate the deflection behavior of a multiple leaf spring under centrally applied load and to measure proof load
9. To Verify Euler Theory for fixed ended column carrying an axial load and determine the value of buckling load
10. To verify Euler theory for a thin strut subjected to end loads, and determine the value of crippling load

11. Introduction of ANSYS Software and its different modules
12. Using ANSYS Software (Structural Analysis), determine the deflection in cantilever beam, which is supported at one end
13. Using ANSYS Software (Structural Analysis), determine the deflection in I beam, which is supported at one end
14. Using ANSYS Software (Structural Analysis), Analyze the following truss and find the displacement, and reactions at each node. Also find the stresses produced
15. Determine the stress produced and the reaction forces at the ends and analysis of stepped bar

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

- Lab Manual

ENGINEERING BREADTH COURSES

SHIP STRUCTURE-I

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

To study advanced cases of mechanics of materials specific to the behavior of materials in special structural load cases of buckling of columns, bending of initially curved beams, stresses in pressurized vessels under rotation and thermal influence.

COURSE LEARNING OUTCOMES

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

1. Understand the concepts and theories of ship structural analysis and design procedure
2. Analyze stresses and strains in primary hull structures, tertiary members (Plates and beams) under different wave loadings
3. Design ship structural members based on theories failure.

COURSE CONTENT

1. Analysis of stress and strain in two and three dimensions
2. Principal stresses and strains
3. Mohr's circle for stress and strain
4. Thick walled pressure vessels
5. Symmetrical and asymmetrical loading
6. Introduction to fracture mechanics
7. Impact loading
8. Fatigue and creep
9. Virtual work
10. Theories of elastic failure
11. Theory of columns

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Beer and Johnston, Mechanics of Materials, Publisher: McGraw Hill, Year: 1992.
2. R.R. Craig, Design of Ship Hull Structures.
3. K.J. Rawson, E.C. Tupper, Basic Ship Theory Vol 1.

HYDRODYNAMICS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

To develop in the students an ability to apply fluid-flow governing equations to incompressible flows, compressible flows and turbo-machines.

COURSE LEARNING OUTCOMES

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

1. Implement differential analysis on fluid element to interpret motion of inviscid and viscous fluids.
2. Analyze the flow characteristics in (a) pipes, (b) over external surfaces and (c) in open channels.
3. Use Computational Fluid Dynamics (CFD) to demonstrate various fluid flow characteristics..

COURSE CONTENT

1. Fluid element kinematics, Velocity and acceleration field revisited linear motion and deformation
2. Conservation of mass, differential form of continuity equation, cylindrical polar coordinates, stream function.
3. Conservation of linear momentum, description of forces acting on differential element, equation of motion. Inviscid flow, Euler's equation of motion, the Bernoulli's equation, Irrotational flow, the BE for irrotational flow.
4. The velocity potential. Some basic plane potential flows, uniform flow, source and sink, vortex, doublet.
5. Superposition of basic plane potential flows, source in a uniform stream, half body, Rankine oval, flow around cylinder.
6. Viscous flow, stress deformation relationship, the navier stokes equation, Some solution of viscous incompressible fluid.
7. Steady laminar flow between fixed plates, coquette flow, steady laminar flow in circular tube, steady axial laminar flow in annulus.
8. General characteristics of pipe flow-Laminar and turbulent flow, entrance region and fully developed flow, Pressure and shear stress
9. Fully developed laminar flow- From F=ma applied to a fluid element. From the Navier – Stoke equation. From dimensional analysis.
10. Energy consideration. Fully developed Turbulent flow-Transition from laminar to Turbulent flow, turbulent shear stress, and turbulent velocity profile.

11. Dimensional analysis of pipe flow-The moody chart, minor losses, noncircular conduits, Pipe flow examples- single pipe, multiple pipe system
12. General external flow characteristics, lift and drag concepts. Characteristics of flow past an object.
13. Boundary layer characteristics, BL structure and thickness on flat plate, transition from laminar to turbulent flow, turbulent boundary layer flow, effect of pressure gradient, momentum integral BL equation with nonzero pressure gradient.
14. Drag, friction drag, pressure drag, drag coefficient data and example. Lift, surface pressure distribution, circulation.
15. Introduction to turbo machines, basic energy consideration, basic angular momentum consideration.
16. The centrifugal pump theoretical considerations, and performance characteristics, net positive suction head, system characteristic and pump suction, Dimensionless parameter and similarity laws, special pump scaling laws, specific speed, suction specific speed.
17. Axial flow and mixed flow pumps, fan, turbines and compressors.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Munson, Young, Okiishi, HT John, Fundamentals of Fluid Mechanics, Publisher: J. Wiley & Sons.
2. Philip J. Pritchard and John C. Leylegian, Fox and McDonald's Introduction to Fluid Mechanics, Publisher: Wiley & Sons.
3. Frank M. White, Fluid Mechanics, Publisher: McGraw Hill.

HYDRODYNAMICS LAB

Credits: 0+1
Pre-Requisite: Nil

DESCRIPTION

To supplement the theoretical knowledge of fluid mechanics with laboratory experiments.

COURSE LEARNING OUTCOMES

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

1. Conduct Fluid Mechanics related experiments and analyze/interpret experimental data.
2. Demonstrate the basics of lab safety, good housekeeping and safe working habits individually as well as team members.
3. Use techniques, analytical skills and engineering tools.

COURSE CONTENT

1. To determine the relationship between head loss due to friction, and velocity for flow of water through smooth bore pipes.
2. To confirm the head loss predicted by the pipe friction equation associated with flow of water through smooth and roughened bore pipes.
3. To determine the loss coefficients associated with flow of water through standard fittings used in plumbing installations.
4. To determine the head loss associated with different flow rate measuring devices.
5. To determine the key parameters of a pontoon and to investigate its stability.
6. To determine the center of pressure on both submerged and partially submerged plane surface and compare its value experimentally and theoretically.
7. To demonstrate the application of dead weight tester in bourdon pressure gauge calibration
8. To demonstrate the phenomenon of choking.
9. To demonstrate the effect of the inlet pressure on the mass flow rate with constant back pressure and compare it with the theoretical prediction.
10. To determine the effect of back pressure on mass flow rate.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

- Lab Manual.

SHIP DYNAMICS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Students will learn about the basic principles of ship dynamics and their application for design development and ASSESSMENT:

COURSE LEARNING OUTCOMES

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

1. Identify sources and effect of ship vibration
2. Analyse free vibrations of harmonically excited systems by application to a single DoF system
3. Apply numerical methods for determining the natural frequencies and mode shapes of a given system.

COURSE CONTENT

1. One degree of freedom spring-mass-dashpot systems in translation and rotation.
2. Free motion, natural frequency, damping ratio, logarithmic decrement. Forced (sinusoidal) motion, resonance, and magnification factor.
3. Two degrees of freedom systems in translation and/or rotation. Free motion and natural frequencies.
4. Forced (sinusoidal) motion, resonance and motion amplitudes. Response of one degree of freedom systems to non-sinusoidal excitation. Describe the limitations of vibration analysis based on simple beam theory. Describe higher order beam theory and when this is most applicable.
5. Describe the various forms of, issues with & sources of ship vibrations, and implications for ship design.
6. Describe the sources and effects of mechanical system vibrations and outline limits/regulations/treatment methods for airborne noise.
7. Conduct a vibration ASSESSMENTof ship borne structure.
8. Response Amplitude Operator (RAO), Fourier series representation, discrete frequency spectra.
9. Introduction to random processes and applications in linear systems.
10. Rigid body motion of floating structures. Sea wave excitation

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. William T. Thomson, Theory of Vibrations with Applications, Publisher: Prentice Hall, Edition: Latest Edition.
2. Leonard Meirovitch, Fundamentals of Vibrations, Publisher: McGraw-Hill, Edition: 1st Edition, Year: 2001.

SHIP HYDROSTATICS AND STABILITY

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to equip students with the knowledge of one of the fundamentals of ship designing i.e. ship stability

COURSE LEARNING OUTCOMES

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

1. Calculate Ship Hydrostatic data using curves and empirical formulas
2. To understand the stability methods to predict ship stability
3. Analyze the stability of ships by applying fundamental hydrostatic principles.

COURSE CONTENT

1. Methods for calculating a ship's hydrostatic properties, including calculation of areas, volumes, centroids, and important hydrostatic parameters such as Δ, LCF, LCB, KB, KM, TPI, MT1"
2. Ship's lines drawing, Bonjean curve
3. Basic intact, impaired and damaged stability characteristics of a ship. Specifically, calculate metacentric height (GM), calculate and plot righting arm curves (GZ), and calculate changes in drafts and trim for weight additions, removals, or shifts
4. Methods to calculate a ship's damaged stability and trim and determine required watertight subdivision, including development of floodable length curves
5. Design criteria for assessing intact and damaged stability of naval and merchant ships, including intact and damaged heeling moment and righting energy criteria, and extent of damage and watertight subdivision criteria
6. Characteristics of submarine hydrostatics, stability and trim, including the equilibrium polygon, and basic hydrostatic and hydrodynamic effects on depth control.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

Thomas Gilmer and Bruce Johnson, Introduction to Naval Architecture, Year: 1982.

SHIP RESISTANCE AND PROPULSION

Credits: 3+1
Pre-Requisite: Nil

DESCRIPTION

This course identifies the fundamental aspects and describes practical approaches for ship resistance and associated propulsion including propeller design and engine selection. students will estimate the ship resistance and design propeller to fulfil the propulsion requirement.

COURSE LEARNING OUTCOMES

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

1. Determine ship resistance/ power requirement using empirical methods
2. To be able to solve/predict ship resistance using modern commercial ship designing software
3. To be able to design a suitable propeller for a given ship

COURSE CONTENT

1. Basic fluid properties, boundary layers, Flow separation and pressure drag
2. Components of Ship Resistance
3. Dimensional analysis
4. Ship Resistance Prediction methods
5. Ship-model correlation
6. Ship Roughness and Fouling
7. Elements of power and efficiency
8. General Introduction of propulsion requirements and modern types of marine propulsion system
9. Propulsors: Review of marine propulsor types and applications
10. Cavitation and its effect on propeller performance
11. Ducted propeller performance
12. Powering/Propulsor Case Study

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

Christopher Patterson, Ship Stability, Powering and Resistance, Publisher: Adlard Coles Nautical, Edition: 1st Ed (2014), ISBN: 978-1-408176-12-2.

MARINE ENGINEERING

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to equip students with the knowledge of the Marine Engineering.

COURSE LEARNING OUTCOMES

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

1. To understand science of various marine prime movers and discuss the environmental and sustainability aspects
2. To be able to select/ integrate marine prime mover as per requirement
3. To be able to manage the general layout requirements of typical machinery spaces incorporation during ship design phase.

COURSE CONTENT

1. Marine prime movers: Science of Diesel engines
2. Science of Steam turbines, gas turbines, combined cycle power plants
3. General layout of typical machinery spaces and MCR
4. Auxiliary Systems and Equipment - Bilge; Ballast; Main sea water; Domestic and sanitary hydrosphere; Compressed air; Refrigeration; Heating; Ventilation; Air-conditioning; Steering; Stabilizing; Desalination plant; Gearing; Deck machinery; Safety equipment
5. Marine fuels, emissions and emission control. Power distribution/ transmission and reduction gears.
6. Bearing selection and lubrication
7. Engine-propeller matching, Propeller excitation, added mass, and damping. Vibration modeling, analysis and evaluations of shafting systems: torsional, longitudinal and lateral vibrations

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. RL Harington (ed), Introduction to Marine Engineering, Publisher: ImarE/RINA DAT, Edition: 2nd Edition.

SHIP DESIGN & PRODUCTION

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

To familiarize students with the process of initial ship design and production methods

COURSE LEARNING OUTCOMES

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

1. Explain the design philosophy of ship
2. Analyze/investigate various ship's characteristics
3. Synthesis an early-stage concept design of ship.

COURSE CONTENT

1. Introduction to Ship Design
2. The Phases of Design, Investigation of the concept, Ship Synthesis Procedure
3. Step to step Procedure for Monohull, Weight and Space, Margin Policy, Weight and space driven design and its relationship to density, Ship General Arrangement
4. Design for minimum power, Calculation of warship complement, Merchant Ship Complement
5. Management of Trim/ Calculation of Tankage Position, Light Condition, Worst Seagoing Condition, Operability Assessment of ship
6. Cost Estimate, Unit Production Cost, Through Life Cost
7. Initial Sizing, Parametric Survey, Detailed Design
8. Design Procedure for Advanced Marine Vehicles eg, SWATHs Trimaran, SES
9. Introduction to Ship Production

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Ship Design and Construction, 2 vols., Publisher: SNAME, Year: 2003.

ENGINEERING DEPTH COURSES

SHIP SEAKEEPING

Credits: 3+1
Pre-Requisite: Nil

DESCRIPTION

To develop concepts of seakeeping

COURSE LEARNING OUTCOMES

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

1. Examine wave spectral properties and infer its effect on ship seakeeping
2. Identify the seakeeping behavior of ships due to varying seaway and ship characteristic variables
3. To be able to predict ship seakeeping behavior using engineering software

COURSE CONTENT

1. **Regular Wave Properties:**
2. Wave length, phase velocity, wave number, wave slope and velocity potential. Dependencies of phase velocity and wave frequency on water depth. Encounter frequency: relationship between ship speed, heading and wave frequency (or number) in head and following waves.
3. **Wave Statistics:**
4. Review of statistical methods; probability density and distribution function; Rayleigh and Gaussian distributions; of probability of exceedance; Mean, Mean Square and significant values. Introduction to random processes. Irregular seaway, Fourier transform, Wave energy spectra, Definition of standard wave spectra (Pierson-Moskowitz, ITTC, and ISSC), Directionality and spreading.
5. **Systems with One and Multiple Degrees of Freedom:**
6. Waves Equations of motion for heave, pitch and coupled heave and pitch in regular waves. Added mass, hydrodynamic damping and their evaluation. Generalization to six degrees of freedom. Relationships between excitation and response. RAOs; Response spectra, RMS values. Absolute and relative motions. Equation of roll motion in regular waves. Roll control devices and active control.
7. Harmonic Motion Review, Regular Waves, Ocean Waves/Wave Spectrum, Vibration Review, Linearized Equations of Motion, Strip Theory, Coupled Heave and Pitch Motions, Linearized Roll Motion Ship Motions in Regular Waves, Ship Motions in Irregular Waves, Seakeeping Considerations in Design.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS
1. A.R.J.M. Lloyd, Seakeeping: Ship Behaviour in Rough Water, Publisher: ARJM Lloyd, Gosport, Hampshire, UK, Year: 1998.
2. R.B. Bhattacharyya, Dynamics of Marine Vehicles, Publisher: John Wiley & Sons, New York, NY, Year: 1978.

ADVANCED MARINE VEHICLES

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

The aim of this course is to provide the basic knowledge of advanced marine vehicles

COURSE LEARNING OUTCOMES

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

1. Understand basic physics of advanced marine vehicles
2. Analyze various advanced marine vehicles for selection of suitable hullform

COURSE CONTENT

1. Definition of Advanced Marine Vehicle, Their requirement, Types, etc.
2. Physics of Planning craft, Generation of Hydrodynamic forces, Hull geometry, Estimating planning forces, behavior of planning craft.
3. Introduction to hovercraft and SES, Hovering flight, flight over land, fight over water, flexible skirts, forces on amphibious ACV, forces on SES
4. Hydrofoils, Types of Hydrofoils, Generation of lift by foils, geometry of hydrofoil sections, effect of finite span, hydrofoils close to a free surface, forces in steady motion, take off, drag breakdown
5. Definition of SWATH, Resistance components, control surfaces, Munk Moment, structural design
6. Trimaran, Configuration, resistance, stability, seakeeping and structure
7. Comparative studies and analyses of various AMVs wrt Speed, economy, seakeeping, style and structure

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. B.R. Clayton, R.E.D. Bishop, Mechanics of Marine Vehicles, Publisher: Gulf Publishing Co, Location: Houston, TX, Year: 1982.
2. E.V. Lewis (Editor), Principles of Naval Architecture: Volume III – Motions in Waves and Controllability, Publisher: SNAME, Location: New York, NY, Year: 1988.

SHIP STRUCTURE -II

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Deepen knowledge of ship structures

COURSE LEARNING OUTCOMES

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

1. Analyze basic beam and plate bending and buckling
2. Apply the concepts and methods of ship structure
3. Design of preliminary ship structures.

COURSE CONTENT

1. **Bending of beams**: Revision Shear force, bending moment and deflection.
2. **Buckling of beams Straight strut under axial load**: Euler theory. Behavior of real struts (eccentric load; initially curved strut, strut with a uniform lateral load; design curves).
3. **Shear stresses in a beam:** Arbitrary cross section with one axis of symmetry. Thin walled open sections and shear centre. Principal stresses
4. Longitudinal strength of ships Weight, buoyancy and load distributions. Still water analysis – shear force, bending moment, slope and deflection; stresses. Quasi static analysis of a ship poised on a wave. Approximate methods and regulations in brief. Cross section properties including effects of different materials. Effect of adding/subtracting material to cross section
5. **Redundant beams:** Double integration with step functions (Macaulay's method). Method of superposition. Slope deflection equations (moment area method). Beams on multiple supports and Theorem of three moments. Moment distribution (Hardy-Cross) method with particular reference to transverse strength of ships. Introduction to grillages.
6. **Beam Stress Analysis:** Composite beam bending Midship section analysis Beam buckling Stress superposition More thorough evaluation of stress
7. Efficiency of structure and superstructure. Ultimate longitudinal strength. Statistical derivations, reliability methods. Philosophies and ship structural design procedures, cost, optimization. Transverse torsional and lateral strength. Continuity details. Bulkheads. FEM applications. Unconventional vehicles and structures. Introduction to theory of plates

8. Combined stress ASSESSMENTof hull girder.
9. Combined stress ASSESSMENTof hull girder.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Evans, J.H. (Editor), Ship Structural Design Concepts, Publisher: Cornell Maritime Press, Year: 1975 (a second volume of this book was added in 1983; it is subtitled `Second cycle').
2. Hughes, O.F., Ship Structural Design, Publisher: Wiley-Interscience, Published by the Society of Naval Architects and Marine Engineers, New York, Year: 2010.
3. Lewis, E.V. (Editor), Principles of Naval Architecture, Vol. I Chapt 4., Publisher: SNAME, Year: 1975.
4. Rawson, K.J., and Tupper, E.C., Basic Ship Theory, Volume 1, Publisher: Longman, Edition: 3rd Ed, Year: 1983.
5. Okumotu, Y., et al., Design of Ship Hull Structures, Publisher: Springer-Verlag, Year: 2009.
6. Williams, M.S., and Todd, J.D., Structures-Theory and Analysis, Publisher: Macmillan Press, Year: 2000.

SHIP MANEUVERING

Credits: 3+1
Pre-Requisite: Nil

DESCRIPTION

Introduce and explain the concepts of ship maneuvering

COURSE LEARNING OUTCOMES

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

1. Apply maneuvering equations to predict directional stability
2. To understand the effect of using Control Surfaces on ship maneuvering
3. To be able to solve/predict maneuvering characteristics of a marine platform using commercial software.

COURSE CONTENT

1. Body axes, translations and angular velocities
2. Transformation of axes.
3. General equations of motion in calm water.
4. Linearized equations of symmetric motion.
5. Linearized equations of antisymmetric motion.
6. Fluid actions and slow motion derivatives.
7. Measurements of slow motion derivatives (tow and rotating arm tests).
8. Measurements of oscillatory coefficients (planar motion mechanism).
9. Control surfaces and derivatives.
10. Directional stability criteria (Routh-Hurwitz test functions).
11. Details of types of stability.
12. Maneuvering trials (stability: pull out and spiral)
13. Maneuvering trials (control: circle and zigzag)
14. Effects of variables on design (speed, trim, draught, etc).
15. Rudder forces and torques.
16. Rudder design, effects of rudder.
17. Ship/model correlations.
18. Full scaled trials

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. B.R. Clayton and R.E.D. Bishop, Mechanics of Marine Vehicles, Publisher: Not specified.
2. E.V. Lewis, Principles of NA, Vol. III, Publisher: SNAME, Year: 1988.

FINITE ELEMENT METHODS AND MARINE APPLICATIONS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

To introduce students to finite element analysis with aim to develop students' knowledge and skills in this areas for solving engineering problems.

COURSE LEARNING OUTCOMES

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

1. Solve linear, structural, thermal, dynamic and couple field problems using basics of finite element methods
2. Analyze structural, thermal, dynamic problems.
3. Work individually and as team member to solve engineering problems using finite element method software

COURSE CONTENT

1. **Introduction to FEA and Element Performance**
   - Introduction to Finite Element Modeling and preliminary decisions elements types and their properties
   - Basic concepts of equilibrium &compatibility
   - General factors affecting element performance – Sources of errors
   - Convergence.
2. **FE Methods, Shape Functions, Stiffness Matrix and Transformation**
   - Direct Stiffness Method, Energy Methods
   - Shape Function: Linear and Quadratic Element
   - Beam Elements, Truss Elements, Linear and Planar elements
   - Stiffness matrix, Local to Global Co-ordinate Transformation Assembly
3. **Static Structural Analysis**
   - Modeling and analysis of 1D, 2D and 3D structures under static loading
4. **Dynamic Analysis**
   - Introduction to different types of dynamic analysis
5. **Modal Analysis, Frequency Response Analysis, Transient Response Analysis, Master Degrees of Freedom**

SUGGESTED INSTRUCTIONAL/ READING MATERIALS
1. Richard G. Budynass, Advanced Strength and Applied Stress Analysis, Publisher: McGraw Hill, 2. Saeed Moaveni, Finite Element Analysis – Theory and Applications with ANSYS, Publisher: Prentice Hall, 3. M J Fagan, Finite Element Analysis – Theory and Practice, Publisher: Pearson Publications,

*** List of Technical Electives (2+0)
• Submarine & Submersible Design • Design of Small Crafts • UUV and Submarine Control & Manoeuvring • Design of Offshore Marine Structures • Port and Harbour Engineering • Coastal Engineering • Ocean Environmental Engineering • Underwater Work Systems • Ship Survey & Incident Investigation • Advanced Marine Structures • Design of Foundation for Marine Structures • Marine Production Tooling & Automation • Advanced Marine Manufacturing Processes • Fuel Cell Technology For Marine Applications • Corrosion • Computational Fluid Dynamics and Marine Applications • Marine Environmental Issues • Submarine Structures • Ship Repair & Maintenance • UUV and Submarine Control & Maneuvering

SUBMARINE & SUBMERSIBLE DESIGN

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

The objective of this course is to have understanding of submarine and submersible design. It covers the topics of buoyancy and stability, resistance and propulsion, mission requirements, auxiliary systems, structural design, construction methods, and modern design approaches.

COURSE LEARNING OUTCOMES

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

1. Apply principles of hydrostatics and stability in the analysis of a submarine hull and factors driving hull shape and volume.
2. Analyze submarine design parameters related to cost, weight and capability.

COURSE CONTENT

1. Submarine Design History
2. Parametric Design
3. Volume Requirements and Arrangements
4. Submarine Hydrostatics
5. Weight Estimation
6. Equilibrium Polygon
7. Curves of Form Generation for a Body of Revolution
8. Pressure Vessels
9. Structural Design

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Burcher and Rydill, Concepts in Submarine Design, Year: 1994.
2. Jackson, Submarine Concept Design,

DESIGN OF SMALL CRAFTS

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

This course aims to provide critical analysis, platform design, project management and technical writing skills. Each student will be required to contribute an individual small craft design project over extended period of time and produce a coherent body of work to a deadline.

COURSE LEARNING OUTCOMES

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

1. Understanding of fundamental naval architecture principles for the designing of small crafts
2. Use computer-aided engineering (CAE) tools and associated analytical processes.
3. Develop a concept design for small crafts.

COURSE CONTENT

1. Technology Development and Innovation in Ship Design, Principles of Marine Design
2. Design Methodology (Design Spiral and Work Breakdown Structure)
3. Hull Geometry and Hull Design/Layout + Computer-Aided Engineering (CAE) Tools and Practices
4. Propulsion Systems + Hydrostatics and Stability
5. Hull Construction, and Scantling Determination.
6. Material Selection, Fabrication Tools/Processes, and Composite Material Concepts
7. Economics and Costing
8. Design exercise for small crafts

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Larsson, Eliasson, and Orych, Principles of Yacht Design, Edition: Fourth Edition, Year: 2014.
2. Gougeon, The Gougeon Brothers on Boat Construction, Year: 2005.

UUV AND SUBMARINE CONTROL & MANOEUVRING

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

The primary objective of this course is to apply engineering principles and acquaint the student with design and operational considerations for manned submersibles and unmanned underwater vehicles (UUVs).

COURSE LEARNING OUTCOMES

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

1. Apply basic engineering principles to the analysis of underwater work systems
2. Understand modern concepts for unmanned systems
3. Evaluate design and operational considerations for unmanned underwater vehicles (UUVs)

COURSE CONTENT

1. The Underwater Environment
2. Underwater Intervention Methods
3. Submerged Body Hydrostatics
4. Submerged Body Hydrodynamics
5. Autonomous System Design
6. Electronic/Control Systems, Sensors, and Power Distribution
7. Basic Autonomy, Control Algorithms, and Control System Integration

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Hawley, Design Aspects of Underwater Intervention Systems, Year: 1996.

DESIGN OF OFFSHORE MARINE STRUCTURES

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

To provide the basic and some advanced elements for design of offshore structures. To understand the design criteria on more complex steel elements (tanks, pipes, plates,shell, etc) and criteria for life extension of existing off shore platforms.

COURSE LEARNING OUTCOMES

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

1. Apply principles of structural mechanics to offshore platforms
2. Catalogue wave induced loads on floating structures using numerical methods
3. Design an offshore platform capable of meeting user requirements.

COURSE CONTENT

1. Introduction to offshore structures and problems of offshore structures.
2. Hydrodynamic Classification of structures
3. Review of Sea Environment; basic assumptions, wave theory, wind and current
4. Discussion on linear wave induced motions and loads on floating platforms and intro to numerical methods for determining loads and motions
5. Current and wind loads on offshore structures Station keeping
6. Fabrication and installation of offshore structures
7. Corrosion protection techniques for offshore structures

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. D.V. Reddy and A.S.J. Swamidas, Essentials of Offshore Structures: Framed and Gravity Platforms

PORT AND HARBOUR ENGINEERING

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

To understand the various aspects of port and harbor engineering such as; planning, designing, and economic issues

COURSE LEARNING OUTCOMES

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

1. Understand vessel characteristics and types and general design considerations
2. Examine ship berthing and maneuvering considerations including fender system design
3. Solve environmental and operational loads on vessels.

COURSE CONTENT

1. Introduction to Port and Harbor Engineering
2. Vessel Characteristics and Types
3. General Design Considerations
4. Environmental Factors, Material Selection
5. Berthing Loads and Fender System Design, Mooring Loads and Design Principles
6. Channels and Turning Basins
7. Inlets and Jetties, Small Craft Harbors, Operational and Environmental Loads

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Per Bruun, Port Engineering, Publisher: Not specified.
2. A.D. Qinn, Design and Construction of Ports and Marine Structures, Publisher: Mc Graw-Hill.
3. PHRI (Port and Harbour Research Institute) Japan manual, Publisher: Not specified.
4. Gregory Tsinker, Handbook of Port Harbour Engineering: Geotechnical and Structural Aspects, Publisher: Not specified.
5. Ben C. Gerwick, Construction of Marine and Offshore Structures, Publisher: CRC Press, Taylor and Francis Group.
6. R.N. Bray, A.D. Bates, J.M. Land, Dredging: A Handbook for Engineers, Publisher: John Wiley & Sons, Inc.
7. Edited by Hans Agershou, Planning and Design of Ports and Maritime Terminals, Publisher: Thomas Telford, Edition: 2nd.

COASTAL ENGINEERING

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

The course is based on developing an understanding of the theory and application of waves, tides and sediment transport and their application in the nearshore coastal zone. Other topics include nearshore processes, statistical modelling of return periods, offshore outfalls, beach protection, wave generation, harbor design, and coastal management.

COURSE LEARNING OUTCOMES

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

1. Understand the physics of the ocean (currents and waves) and the basic processes occurring in the coastal zone and their effects on the coast, port and waterways infrastructure
2. Analyze data, and information from different sources using coastal and oceanographic numerical modelling techniques
3. Characterize Social responsibility of business and entrepreneurship in the Socio-economical exploitation of the coastal zone

COURSE CONTENT

1. Introduction to coastal design
2. Water waves and their analysis
3. Wave generation, transformation and breaking
4. Tide and Water Levels
5. Design of Structures
6. Introduction to coastal management
7. Coastal Sediment transport
8. Basic Shore processes and shore protection
9. Contemporary concepts in coastal design

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Leo H. Holthuijsen, Waves in Oceanic and Coastal Waters, Publisher: Cambridge University Press, Year: 2007.
2. Vallam Sundar, Sannasi Annamalaisamy Sannasiraj, Coastal Engineering: Theory And Practice, Publisher: World Scientific, Year: 2019.
3. J. William Kamphuis, Introduction to Coastal Engineering and Management, Publisher: Advanced Series on Ocean Engineering: Volume 30, Edition: 2nd.

OCEAN ENVIRONMENTAL ENGINEERING

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

An introduction to basic principles and current issues in environmental engineering as applied to the ocean environment. Topical coverage includes chemical and biological considerations in water quality, diffusion and dispersion in estuaries and oceanic environments, engineering methods used to analyze and mitigate the effects of marine pollution, and environmental ethics and regulatory statutes.

COURSE LEARNING OUTCOMES

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

1. Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
2. Solve environmental engineering problems by applying principles of engineering, science, and mathematics
3. Design solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

COURSE CONTENT

1. Related subjects for Environmental engineering
2. Definition of water pollution, classification, water pollutants
3. Biodegradation, Aerobic and anaerobic degradation
4. Effects of pollution on lakes, eutrophication, temperature-depths relationships
5. Measurements of water quality: DO, BOD, COD, solids, nitrogen, phosphorus
6. Water treatment
7. Wastewater treatment
8. Sludge treatment and disposal
9. Role of engineer in ocean environment management

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Gilbert Masters, Wendell Ela, Introduction to Environmental Engineering and Science, Publisher: Pearson, Edition: 3rd edition, Year: 2007.

UNDERWATER WORK SYSTEMS

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

The primary objective of this course is to apply engineering principles and acquaint the student with design and operational considerations for manned submersibles, unmanned remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), and one atmosphere deep dive systems.

COURSE LEARNING OUTCOMES

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

1. Apply basic engineering principles to the analysis of underwater work systems
2. Analyze design and operational considerations for underwater work systems
3. Infer in-depth, technical research using scientific literature.

COURSE CONTENT

1. The Underwater Environment
2. Underwater Intervention Methods
3. Materials And Corrosion
4. Submerged Body Hydrostatics
5. Submerged Body Hydrodynamics
6. Underwater Energy Storage and Conversion
7. Propulsion Systems
8. Underwater Tools
9. Underwater Inspection Techniques
10. Engineering Design

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Hawley, Design Aspects of Underwater Intervention Systems,, Year: 1996

SHIP SURVEY & INCIDENT INVESTIGATION

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

This course covers different aspects and procedures of ship survey and marine incident investigation The main objective of this course is to increase the competency and interest of the students in the field of marine surveying

COURSE LEARNING OUTCOMES

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

1. Discuss the different types of marine surveys in detail along with the roles and responsibilities of the marine surveyor
2. Apply the required knowledge of associated international regulations and conventions
3. Discuss the surveyor's role in incident and accident investigation.

COURSE CONTENT

1. Introduction to Marine Surveying
2. Relationship between surveyors and their clients
3. Business Skills for Surveyors
4. Laws and Conventions related to marine surveying. Marine Surveying and Insurance
5. The Surveyor's role in incident and accident investigation vis-à-vis Role of Naval Architects in Marine Surveying
6. Hull and Structural Surveys
7. Initial action in an investigation
8. Human Factor in Incident Investigation
9. Managing the Investigation. Witnessing and Interviewing

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Capt Ashok Menon, Maritime Accident and Incident Investigation,
2. Harry Karanassos, Commercial Ship Surveying,

ADVANCED MARINE STRUCTURES

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

This course is an attempt in the direction of explaining various stages of the analysis and design of marine structures. To give an overall idea of the various types of marine structures constructed for offshore oil and gas exploration, various environmental loads, ultimate load design, fluid–structure interaction, fatigue, and fracture

COURSE LEARNING OUTCOMES

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

1. Understand the effect of various ocean loads on structure design
2. Apply ultimate load approach for computing strength of marine structures
3. Evaluate strength of marine structures using probabilistic approaches.

COURSE CONTENT

1. Introduction to offshore structures and Environmental loads
2. Ultimate load design: Plastic analysis, Ultimate load carrying capacity, Framed structures, Failure Theories, Structural Design Using Shipping Code
3. Fluid Structure Interaction: Flow in deep waters, TLP Model, wave structure interaction
4. Reliability of Marine Structures: Deterministic and probabilistic approaches, Formulation of reliability problem
5. Fatigue and Fracture: Fatigue analysis in time domain and spectral domain, Deterministic fatigue analysis, Correction factors for fatigue damage analysis, crack propagation.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Srinivisan, Advanced Marine Structures.
2. Takeshi Ishida, Advanced Marine Structures.

ADVANCED SUBMARINE STRUCTURES

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

The purpose of this course is to broaden the basis for Assessment of the pressure hull of submersibles and submarines. Learning the Assessment methodology of different types of failures that can occur in submarine pressure hull

COURSE LEARNING OUTCOMES

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

1. Explain the Understand the different types of failures that can occur in submarine pressure hull.
2. Analysis of domes and cones for submarine pressure hull.in use of ICT platforms and tools.

COURSE CONTENT

1. Introduction to Submarine Structure
2. Interframe Yield in Submarine Pressure Hull
3. Interframe Buckling in Submarine Pressure Hull
4. Collapse Failure in Submarine Pressure Hull
5. Overall Buckling and Collapse in Submarine Pressure Hull
6. Domes and Cones in Submarine Pressure Hull
7. Bulkheads Assessment in Submarine Pressure Hull

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Roy Bucher, Ocean Technology series 2: Concepts in Submarine Design.
2. E C Tupper, Introduction to Naval Architecture.
3. Submarine Technology for the 21st Century.

DESIGN OF FOUNDATION FOR MARINE STRUCTURES

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

This course presents and discusses different aspects of foundation design that distinguish marine structures foundations from conventional foundation design

COURSE LEARNING OUTCOMES

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

1. Estimate loading conditions experienced by marine structures foundation
2. Understand the structure-soil interaction and failure modes
3. Quantify applied soil stresses and determine whether they will not exceed the soil strength over designed project life time.

COURSE CONTENT

1. Overview of the foundation design and comparison of marine foundations with conventional foundations
2. Procedure and Methodology of site-specific geotechnical investigations
3. In depth analysis of soil characteristics
4. Foundation loading and Response
5. Foundation related failure modes
6. Slip surfaces and Zone failures

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Robert B. Bittner, Deep Marine Foundations: A Perspective on the Design and Construction of Deep Marine Foundations.
2. John W. Gaythwaite, Design of Marine Facilities.

MARINE PRODUCTION TOOLING & AUTOMATION

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

To impart an understanding of the principles concerning the design of cutting tools, jigs, fixtures, dies etc. and automation in marine production industry

COURSE LEARNING OUTCOMES

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

1. Understand design considerations in machine tools
2. Apply knowledge in tool selection and application as per design requirements
3. Understand principles in designing automated industrial machines and processes..

COURSE CONTENT

1. Tool Design Methods and Tool-making Practice
2. Tool Materials and Heat Treatment
3. Design of Cutting Tools
4. Clamping, Drill Jigs and Fixture Design
5. Design of Sheet-metal Blanking and Piercing Dies
6. Design of Sheet-metal Bending, Forming and Drawing Dies.
7. Automation: Introduction to Automations, Automation Strategies, Economics of Automation, Partial Automation. Group technology & Flexible Manufacturing. Use of Sensors and Actuators in Automation.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Tool Design
2. Materials & Processes in Engineering
3. Metal Cutting Theory and Practice.
4. Process Control Instrumentation Technology

ADVANCED MARINE MANUFACTURING PROCESSES

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

With fast technological advancements new techniques of manufacturing are being adopted for quality production. The objective of this course is to impart knowledge of advanced marine manufacturing techniques such as Laser machining, high-speed machining, rapid prototyping and group technology

COURSE LEARNING OUTCOMES

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

1. Describe manufacturing process and technical detail and discuss their applications according to manufacturing requirements
2. Analyze manufacturing tasks, identify relevant manufacturing processes, and perform pertinent calculations

COURSE CONTENT

1. Conventional and Advance Machining Process, High Speed Machining, Manufacturing processes related to marine industry, Casting, Welding, Sheet Metal Fabrication
2. Non-Traditional Machining; Laser Machining and Water Jet Cutting
3. Additive Manufacturing and Rapid Prototyping
4. Application of Composites in Manufacturing
5. Group Technology

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Robert B. Bittner, Deep Marine Foundations: A Perspective on the Design and Construction of Deep Marine Foundations.
2. John W. Gaythwaite, Design of Marine Facilities.
3. Beesley M.J, Lasers and Their Applications.
4. William M. Steen, Laser Material Processing.
5. Bert P. Erdel, High Speed Machining.
6. E.M. Trent, High Speed Machining, Edition: 4th.
7. Keneth G. Cooper, Rapid Prototyping Technology: Selection and Application.
8. Chua Chee Kai, Rapid Prototyping: Principles and Applications.
9. John A. Schey, Introduction to Manufacturing Processes.
10. Roy A. Lindberg, Processes and Materials of Manufacturing, Publisher: Not specified.

11. Paul Degarmo, Materials & Processes in Engineering.
12. Tien-Chen Chang, Computer Aided Manufacturing.

FUEL CELL TECHNOLOGY FOR MARINE APPLICATIONS

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

Understanding the performance characteristics of fuel cell power plant and its components. Outline the performance and design characteristics and operating issues for various fuel cells. Discuss the design philosophy and challenges to make power plant economically feasible as well as environment friendly. At the end of the course, the students will have sufficient knowledge to identify fuel cell technologies to Marine Applications

COURSE LEARNING OUTCOMES

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

1. Explain the utility and application of different fuel cell technologies w.r.t performance, operational issues and challenges.
2. Apply knowledge to solve problems related to fuel cell technology.
3. Explain the advantages of fuel cell technology in terms of its economic viability and impact on the environment.

COURSE CONTENT

1. Introduction

a. Introduction of various fuel cell technologies, need and application in marine systems and machines, advantages, introduction on recent developments in fuel cell technology

2. Fuel Cell Voltages

a. Efficiency and Open Circuit Voltage, Operational Fuel Cell Voltages

3. Types of Fuel Cells

a. PEM Fuel Cells, Alkaline Electrolyte Fuel Cells, Direct Methanol Fuel Cells, Solid Oxide Fuel Cells, Phosphoric Acid Fuel Cells, Molten Carbonate Fuel Cells

4. Fuels

a. Fuels and Fuel Reforming

5. Heat Exchangers and Thermal Systems

a. Principles, Components and Working

6. Balance of Plant

a. Pumps, sensors, gaskets, compressors, recirculation blowers or humidifier

7. Delivering Fuel Cell Power

a. Introduction, DC Regulation and Voltage Conversion, Inverters, Electric Motors, Fuel Cell/Battery or Capacitor Hybrid Systems

8. Marine Applications

a. Quite Operation Applications, Changine power applications, Submarines and submersibles, Commercial/ Naval ships propulsion and auxiliary power, offshore platforms, remote navigation, refrigeration, economic justification and impact on the environment

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. James Larminie and Andrew Dicks, Fuel Cell Systems Explained, Publisher: John Wiley, Edition: Second Edition, Year: 2003, Location: New York, ISBN: 0-470-84857-X.
2. Marine Applications for Fuel Cell Technology-A Technical Memorandum, Publisher: U.S. Congress, Office of Technology Assessment, Year: February 1986.

CORROSION

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

To provide an understanding of the corrosion principles and engineering methods used to minimize and prevent the corrosion. Basic concepts: Definition and importance, Electro-chemical nature and forms of corrosion, Corrosion rate and its determination.

COURSE LEARNING OUTCOMES

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

1. Understanding of various corrosion processes, protection methods and materials selection
2. The student shall be able to determine the probable corrosion type, estimate the corrosion rate and propose the most reasonable protection method with regard to safety, price and environmental considerations
3. Use knowledge to propose the correct materials, design and operation conditions to reduce the likelihood of corrosion.

COURSE CONTENT

1. Introduction – Corrosion, types and modes of corrosion failures, mechanism of corrosion, Guidelines for investigating corrosion failures.
2. Corrosion Fatigue, Impact of Corrosion on mechanical properties, Factors affecting corrosion, Material selection -Introduction of properties of materials. Acceleration and managing corrosion damage.
3. Electrochemical theory of corrosion, Electrochemical methods for corrosion quantification, Prevention of corrosion damage.
4. Corrosion protection through protective coatings, Coating and coating process, Supplementary Protection systems. Coating materials and properties – Paint coating, metal coating etc. Surface preparation, Rules and regulations for application of coating, Coating Surveys CORROSION INHIBITORS : Classification of inhibitors , Corrosion inhibition mechanism , Selection of an inhibitor system.
5. CATHODIC AND ANODIC PROTECTION Sacrificial Anode CP systems, Impressed Current Systems, Monitoring and Performance of CP systems for marine structures. Anodic Protection – Equipment required for anodic protection, Design concerns. Project: Modeling and Life prediction for corroded

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Pietro Pedeferri, Corrosion Science and Engineering, Publisher: Springer; 1st edition, Year: 2018, ISBN-13: 978-3319976242, ISBN-10: 3319976249.
2. Volkan Cicek, Corrosion Engineering, Publisher: Scrivener Publishing, Year: 2014.
3. Mars G. Fontana, Corrosion Engineering, Publisher: McGraw-Hill, Edition: 3rd, Year: Not specified, ISBN-10: 0070214638.

COMPUTATIONAL FLUID DYNAMICS AND MARINE APPLICATIONS

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

The design and analysis of engineering fluid systems and marine vehicles require the prediction of the fluid behaviour and the interaction between the fluid and the system. This requires a good knowledge of fluid dynamic principles and the behaviour under varying boundary and operational conditions. This unit introduces students to numerical methods used to solve applied fluid dynamics and maritime hydrodynamics. It builds on the knowledge gained in subjects related to ship hydrodynamics, such as fluid dynamics, seakeeping and manoeuvring and resistance and propulsion, and relevant mathematical concepts.

COURSE LEARNING OUTCOMES

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

1. Apply the mathematical formulation of the basic laws governing laminar and turbulent fluid flow
2. Develop an appropriate domain discretization for CFD simulations on typical marine vehicles
3. Evaluate the hydrodynamic forces and flow characteristics of marine vehicles.

COURSE CONTENT

1. Overview of the fluid dynamic equations and their solutions.
2. Introduction to continuum mechanics: Basic idea of a continuum description and how to obtain the flow equations.
3. Introduction to partial differential equations and the Finite Difference Formulations.
4. Stability Analysis.
5. Advance viscous CFD methodologies (focus on FDM and FVM), theoretical and practical aspects.
6. Particular problems as: boundary layer problem and propeller cavitation.
7. CFD analysis Project.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Joel H. Ferziger and Milovan Peric, Computational Methods for Fluid Dynamics, Publisher: Springer, Edition: Second edition.
2. O. C. Zienkiewicz and K. Morgan, Finite Elements and Approximation, Publisher: Wiley.

MARINE ENVIRONMENTAL ISSUES

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

There is increasing interest in marine health as we rely more and more on its goods and services to support an ever-growing population. This is only possible with a full appreciation of marine biodiversity, ecosystem function and the potential consequences of continued human pressures. This course explores whether we can use similar strategies as on land to better manage and govern the marine environment

COURSE LEARNING OUTCOMES

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

1. Understand the historical context to man's links with the marine environment.
2. Demonstrate increased awareness of threats to marine ecosystems around the world, in particular the multiple likely impacts of ongoing climate change.
3. Examine the marine environmental issues of Pakistan and propose viable solutions.

COURSE CONTENT

1. Threats to Marine Systems
2. The consequences of climate change for ocean processes and marine life
3. Balancing marine resources
4. Marine Restoration
5. Living in the sea (new life + Finding food)
6. Beach Safety and Coastal Processes
7. Why our oceans matter

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Fisher, Man and the Maritime Environment,Year: 1994.

SHIP REPAIR & MAINTENANCE

Credits: 2 + 0
Pre-Requisite: Nil

DESCRIPTION

Enable the Students to do following:
Analyze and evaluate the structural and mechanical issues in ship systems, demonstrating proficiency in diagnosing maintenance and repair needs.
Apply advanced problem-solving skills to develop effective repair strategies, considering safety, cost-efficiency, and regulatory compliance.
Demonstrate a deep understanding of ship repair techniques, materials, and tools, and apply them proficiently to restore and maintain various ship components

COURSE LEARNING OUTCOMES

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

1. Lists type of shipyards and their characteristics.
2. Describes the steps involved in preparing a project plan for specific type of maintenance activity.
3. Explains the environmental factors that effects the process of grit blasting and surface preparation.

COURSE CONTENT

1. **An Overview of the Shipbuilding and the Ship Repair industry**
   - An Overview of Shipyards
   - Contribution of yards in global economy
   - Types of Shipyard business models
   - Key Stakeholders
   - Business process flow diagram
   - Health, Safety and Environmental considerations
   - Project management in Shipyard operations
   - Quality Control and Assurance
   - Market Challenges
2. **Ship Specifications**
   - Ship General
   - Hull
   - Equipment for Cargo
   - Ship Equipment
   - Equipment for crew

- Main machinery
- Systems for main machinery
- Ship systems
- Electric and automation systems
- OEMs list and Technical Manuals

3. Pre-Ship Hull Repair Work

- Preparing for a routine planned docking period
- The importance of planning and scheduling
- Typical types of Ship repair undertaken
- Routine maintenance in dock
- Health & safety issues
- Cleaning and preparation for hot work
- Access to work site
- Security issues
- Principle Ship dimensions and Glossary of terms

4. Ship Hull Repair Work

- Stores inspection
- Steel renewal and repair
- Blasting and painting
- Machinery maintenance and repair work
- Propeller, rudder and stem tube work
- Safety considerations
- Non-Destructive testing
- Acceptance certificates

5. Docking and Undocking process

- Docking and types of Docks
- Docking plan
- Ship and dock preparations, establishing clear communications
- Physical inspection of the vessel
- Readiness of personnel, gear and support services
- Special conditions – damaged, listed or trimmed
- The deflection plane and critical stages in the docking process
- Check list of a typical docking procedure
- Weight control and the influence on stability
- Pre-undocking checks on board
- Final dock checks before flooding
- Ballasting and floatation of the ship
- Safety checks before undocking
- Departure from the dock

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. International Chemco Protective Coatings, Comprehensive Guidelines to Ship Maintenance and Repair.
2. DEF STAN 02-155: PART 2, Requirements for Structural Practices in Steel Surface Ships Part 2: Requirements for Survey and Repair of Steel Surface Ships.
3. Don Butler, A Guide to Ship Repair Estimates in Man-Hours.

MULTIDISCIPLINARY ENGINEERING COURSES
MARINE ELECTRICAL ENGINEERING

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

Introduce concepts of electrical engineering with respect to marine applications

COURSE LEARNING OUTCOMES

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

1. Solve basic electrical and electronic circuits
2. Demonstrate basic concepts of electrical and electronic circuits.

COURSE CONTENT

1. Series and Parallel Circuits
2. Introduction to Network Theorems
3. Alternating Current and Inductors
4. RLC Circuits
5. Operational Amplifiers
6. Ship borne Marine Electrical Systems
7. Submarine Electrical System
8. Ship borne Marine Electrical Systems
9. Marine Electrical Systems
10. Ship borne Electronics Equipment

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

- Sergio Franco, Electric Circuits Fundamentals, Publisher: OUP.
- Theodore Wildi, Power Technology, Publisher: Prentice Hall, Edition: 6th.
- S. Chapman, Electric Machinery Fundamentals, Publisher: McGraw, Edition: 4th.
- Basic Electricity, Electric Circuits, Publisher: Schaum's Series.
- Skolnik, Radar Theory, Publisher: Not specified.
- Lawrance J, Introduction to Sonar Systems Engineering.

MARINE CONTROL SYSTEMS

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

To provide basic understanding and engineering analysis of control systems.

COURSE LEARNING OUTCOMES

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

1. Prepare mathematical models of different physical system.
2. Solve engineering problems using mathematical models to examine different properties of the system.
3. Develop physically a controller to achieve the desired response from the system.

COURSE CONTENT

1. **Introduction**. Basics of control system, Open-loop and closed-loop control systems, Block diagrams terminology, Example of system for block diagrams, Signal flow graphs.
2. **Dynamic System modeling**. Mechanical Translational & Rotational Systems, Electrical Active & Passive Systems, Electromechanical Systems, Conversion of Electrical System to Equivalent Mechanical Systems and vice versa, Thermal system and fluid systems.
3. **Laplace Transforms and Transfer Function.** Mason Gain Formula to find transfer function, Mason's formula application of electrical and mechanical systems, Development of nodal equations from signal flow graph, Development of signal flow graph from nodal equations
4. **State Space Formulation**. State space formulation from differential equations, State Space formulation from block diagram and signal flow graphs, Control and Observer Canonical form of block diagrams and state space, Types of inputs like impulse, step, ramp and sinusoidal input, Solution of state space for different responses, System linearization and its applications.
5. **Time Response of 1st Order and Higher Order 2nd Order System**. Time response of the 1st and 2nd order systems (impulse, step, ramp etc.), Time response characteristics, Frequency response of 1st and 2nd order systems, Time response of higher order systems.
6. **Study of System Stability**. Introduction to stability, Poles and Zeros concept, Ruth-Hurwitz stability criteria and its applications, Concept of Root-Locus.
7. **Root Locus Design**. Root Locus design, System stability by pole placement, Compensator Design (Lead and Lag Compensator),

8. Design of PID Controller (P, PI and PID Controllers), Different PID Controller Tuning method.
9. **Frequency Design**. Introduction to frequency plots, Bode Plots, System Stability using Bode Plots.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Katsuhiko Ogata, Modern Control Engineering.
2. John J. D'Azzo and C.H. Houpis, Linear Control System Analysis and Design,
3. Dorf, Feedback Control Systems.

FLEXIBLE ENGINEERING/NON-ENGINEERING COURSES

THERMODYNAMICS

Credits: 3+0
Pre-Requisite: Nil

DESCRIPTION

Introduction of thermodynamic concepts

COURSE LEARNING OUTCOMES

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

1. Apply the fundamental concepts of systems, surroundings, boundary, property, state, equilibrium, process, cycle, pressure, temperature, energy, internal energy, heat, and work as given in classical approach
2. Explain laws of thermodynamics and their important consequences (energy, entropy, degradation of energy, absolute temperature, reversible and irreversible process)
3. Apply concepts related to pure substance, its properties for steam, refrigerants, ideal gases and real gases
4. Analysis of simple thermo-mechanical systems.

COURSE CONTENT

1. Introduction and Basic Concepts: First law of thermodynamics and its applications, System and boundary, Specific volume, pressure and temperature
2. Energy, Energy Transfer, and General Energy Analysis: Equilibrium state, processes, Methods to solve thermodynamics problems
3. Properties of Pure Substances: Phase change processes, P-v-T relation, Property diagrams, Equation of state, specific heats, Compressibility polytropic process relation.
4. Energy Analysis of Closed Systems
5. Mass and Energy Analysis of Control Volumes: Energy analysis of power, refrigeration and heat pump cycles
6. The Second Law of Thermodynamics: Spontaneous and non-spontaneous processes, Thermodynamic cycles, irreversible and reversible process, and Carnot cycle, Clausius inequality.
7. Entropy: Entropy change, T-s diagram, entropy generation, Increase of entropy principle, entropy rate balance of closed systems and control volumes, Isentropic efficiencies

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Cengel, Younus A, Thermodynamics: An Engineering Approach.
2. William Embleton, Leslie Jackson, Paul Anthony Russell, Applied Thermodynamics for Marine Engineers; Reeds Vol 3.

HEALTH SAFETY & ENVIRONMENT

Credits: 2+0
Pre-Requisite: Nil

DESCRIPTION

The course "Health, Safety, and Environment" aims to provide students with a comprehensive understanding of the principles and practices related to maintaining health, safety, and environmental standards in industrial settings. By exploring various aspects of safety management, environmental protection, and regulatory frameworks, students will be equipped to contribute effectively to maintaining a secure and sustainable workplace

COURSE LEARNING OUTCOMES

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

1. Understand the significance of health and safety in industrial contexts
2. Illustrate the importance of maintaining a clean environment wrt environmental pollution, and explain the key provisions of environmental and health and safety acts
3. Comprehends ISO standards to regulatory compliance, risk reduction, and sustainable industry practices..

COURSE CONTENT

1. Introduction of Health and Safety: Industrial Safety: introduction objectives of Safety, Importance of Safety in an industry, Industrial accidents, Effects of accidents, Types of accidents incidence of fire. Fire prevention and control.
2. Techniques of Safety Management: Principles of accident prevention, hazard analysis. Legal, humanitarian, and economic reason for action. Safety inspection procedures. Safety training, First aid and emergency procedures
3. Environment and Health: Introduction: importance of clean environment, Scale of Environmental Pollution. Environmental Act. Health and Safety Act.
4. Atmospheric Pollution: Types of Atmospheric pollution, Their Causes and Effects on Human Health, Available Technologies for Controlling Pollution.
5. Industrial Waste: Solid Waste, Industrial Effluents and Waste Gases, waste treatment plants.
6. Noise Pollution: Measurement of Noise level, Effect of excessive noise on human health. Remedial Measures
7. ISO Standards for Safety and Health and Environment

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

3. J. Ridley and J. Channing, Safety at Works, Publisher: Routledge.
4. K. G. Lockyer, Factory & Production Management, Publisher: Pitman Publishing.

COMPUTER AIDED DRAWING (CAD)

Credits: 0+1
Pre-Requisite: Nil

DESCRIPTION

Develop skills in computer graphics and drawing

COURSE LEARNING OUTCOMES

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

1. Demonstrates the ability to apply different solid modelling operations on CAD software.
2. Apply knowledge to create 3D assemblies using CAD software.

COURSE CONTENT

1. Introduction to CAD
2. 2D and 3D Modeling and Viewing
3. Modeling Aids and Tools
4. Wireframe Modeling
5. Solid Modeling
6. Assembly Modeling
7. CAD Softwares
8. Modeling of machine components in 3D

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Ibrahim Zeid, Mastering CAD/CAM, Publisher: McGraw Hill, Edition: 2005

INTRODUCTION TO MARINE MANUFACTURING PROCESSES

Credits: 1+1
Pre-Requisite: Nil

DESCRIPTION

To familiarize students with conventional and CNC manufacturing.

COURSE LEARNING OUTCOMES

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

1. Discuss various manufacturing processes concerning to marine industry
2. Demonstrate the basics of workshop safety, good housekeeping and safe working habits individually as well as team members.
3. Produce different objects using lathe, milling, shaper and CNC machines.

COURSE CONTENT

1. Advance Measuring Techniques
- a. Measuring System / Standards
- b. Manufacturing Metrology
- c. Limits, Fits Allowances and Tolerances
- d. Calibration of Instruments

2. Machining Technologies
- a. Metal Cutting Theory and Cutting Tools
- b. Manufacturing Standards and Materials and Machine Tools

3. Investment Casting
- a. Introduction to Investment Casting
- b. Practice on Investment Casting
- c. Casting defects
- d. Safety precautions

4. Welding Technology for ship's hull
- a. Spot Welding Techniques
- b. Laser/Plasma Welding
- c. TIG/MIG Welding

5. Introduction to CNC Machines
- a. CNC Milling / Turning
- b. EDM and Wire Cut
- c. CNC Machine Construction and Maintenance
- d. Safety Precautions

6. Hull Lofting
- a. Introduction to Lofting

b. Traditional Lofting Techniques
c. Designing a Hull Surface using Curve Lofting on software
d. Traditional Lofting using Cross Sectional Design Definition

7. Rubber Technology in small crafts
a. Composition
b. Rubber Forming Methods and properties
c. Extruding, Autoclave Processing
d. Machining and Finishing
e. Die Work

8. Fiber Glass and Carbon Fiber for Marine Platforms
a. Description of Materials and their Properties
b. Applications
c. Processes and Methods
d. Machining and Finishing

9. Heat Treatment Processes in Marine applications
a. Annealing, Quenching, Tempering
b. Heat Treatment Cycle
c. Properties and Metals
d. Metallic Structure and Critical Temperatures

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Engr. Muhammad Naweed Hassan, Introduction to Workshop Technology.
2. WA. J Chapman, Workshop Practice.
3. Althouse, Welding Technology.

MARINE FABRICATION METHOD

Credits: 2+1
Pre-Requisite: Nil

DESCRIPTION

This course presents some of the basic techniques used to fabricate offshore structures and ships. Lecture and lab topics develop an understanding of metal, concrete, and composite construction and quality control methods through the manufacturing and testing of small components representative of those used in the marine environment. It also provides information about advanced welding methods used in shipbuilding. To gain the knowledge and skills related to destructive/ nondestructive examination of Metal plates, Welding seams followed by their inspection. To provide information about the preparation of welding plans and to give control of welded structures

COURSE LEARNING OUTCOMES

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

1. To understand the basic processes involved in marine fabrication
2. Select different type of destructive and non-destructive testing methods for a particular given situation
3. While working in teams or individually, Judge weld defects and propose solutions to prevent recurring of the same.

COURSE CONTENT

1. **Advanced Marine Fabrication Methods:**
2. Quality assurance methods in fabrication; Quality control methods in fabrication; Work Breakdown Structures; Designing for crane selection and use; Tolerance; Project time; Assembly and modular construction methods
3. Welding method used in the ship industry, design of welding structures, welding capability, preparation of welding procedures, non-destructive weld examination, welding inspection and quality control.
4. Composite materials; Resin and fiber properties and formats; Basic composite material stiffness and strength analysis; Hand lamination; Bolted and bonded composite joints; Automated composite lamination
5. Quality assurance methods in fabrication; Quality control methods in fabrication; Work Breakdown Structures
6. Designing for crane selection and use; Tolerance; Project time; Assembly and modular construction methods
7. Welding method used in the ship industry, design of welding structures, welding capability
8. Preparation of welding procedures, non-destructive weld examination,

9. welding inspection and quality control. Metal joining; Riveting/ bolting; Brazing
10. Preparation of welding procedures, non-destructive weld examination, welding inspection and quality control. Metal joining; Riveting/ bolting; Brazing
11. Composite materials; Resin and fiber properties and formats; Basic composite material stiffness and strength analysis; Hand lamination; Bolted and bonded composite joints
12. Automated composite lamination Intro to concrete; Mix design (aggregate, w/c ratio, temp)
13. Concrete cylinder fabrication; Concrete fabrication calculations
14. Post-tensioned concrete; Concrete beam fabrication; Concrete QA/ QC; Concrete post-tensioning

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Welding Handbook, Vols. 1-4, American Welding Society, 1997.
2. Welding Journal, American Welding Society.
3. National Vocational and Technical Training Commission Prime Minister's Hunarmand Pakistan Program.
4. Ship Design and Construction, edited by Robert Taggart, Society of Naval Architects and Marine Engineers.

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 COURSE 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 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

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