University College of Engineering Kakinada (A)
Department of Petroleum Engineering & Petrochemical Engineering
R20 Course Structure
B.TECH. PETROLEUM ENGINEERING

COURSE STRUCTURE AND SYLLABUS
for

B.TECH. PETROLEUM ENGINEERING
R20 – Regulation

(Applicable for batches admitted from 2019-2020)

DEPARTMENT OF PETROLEUM ENGINEERING
&
PETROCHEMICAL ENGINEERING,
UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (A),
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, ANDHRA PRADESH, INDIA

Dr. D. Lingaraju Chairman	Shri S.K.S. Charyulu Member	Shri C.V.G. Krishna Member
Prof. K. V. Rao Member	Shri A. Doraiah Member	Shri S. Swarna Raju Member

University College of Engineering Kakinada (A)
Department of Petroleum Engineering & Petrochemical Engineering
R20 Course Structure

B.TECH. PETROLEUM ENGINEERING

Semester I (First year)

Sl. No.	Course Title	Category	Course Code	Hours per week			Credits
				L	**T**	**P**	**C**
1	Mathematics - I	BS		3	0	0	3
2	Engineering Physics	BS		3	0	0	3
3	Engineering Mechanics	ES		3	0	0	3
4	Elements of Mechanical Engineering	ES		3	0	0	3
5	Basic Electrical and Electronics Engineering	ES		3	0	0	3
6	Engineering Workshop and IT Workshop	ES		0	0	3	1.5
7	Engineering Physics Laboratory	BS		0	0	3	1.5
8	Basic Engineering (Mechanical & Electrical) Laboratory	ES		0	0	3	1.5
9	Physics Virtual Laboratory	BS		0	0	2	0
MC	Constitution of India	MC		3	0	0	0
			Total credits				**19.5**

Category	**CREDITS**
Basic Science course	7.5
Engineering Science Courses	12.0
Humanities and social science	-
TOTAL CREDITS	**19.5**

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University College of Engineering Kakinada (A)
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B.TECH. PETROLEUM ENGINEERING

Semester II (First year)

Sl. No.	Course Title	Category	Course Code	Hours per week			Credits
				L	**T**	**P**	**C**
1	Mathematics – II	BS		3	0	0	3
2	Engineering Chemistry	BS		3	0	0	3
3	Communicative English	HS		3	0	0	3
4	Engineering Drawing	ES		1	0	4	3
5	Programming for problem solving using - C	ES		3	0	0	3
6	English Communication Skill Lab	HS		0	0	3	1.5
7	Engineering Chemistry Laboratory	BS		0	0	3	1.5
8	Programming for problem solving using C- Laboratory	ES		0	0	3	1.5
MC	Professional Ethics and Human Values	HS		2	0	0	0
MC	Physical Fitness Activities			0	0	2	0
			Total credits				**19.5**

Category	**CREDITS**
Basic Science course	7.5
Engineering Science Courses	7.5
Humanities and social science	4.5
TOTAL CREDITS	**19.5**

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B.TECH. PETROLEUM ENGINEERING

Semester III (Second year)

Sl. No.	Course Title	Category	Course Code	Hours per week			Credits
				L	**T**	**P**	
1	Mathematics – III	BS		3	0	0	3
2	Petroleum Geology	PCC		3	0	0	3
3	Fluid Mechanics for Petroleum Engineers	PCC		3	0	0	3
4	Heat Transfer Operations	PCC		3	0	0	3
5	Material and Energy Balances	PCC		3	0	0	3
6	Petroleum Geology-Laboratory	PCC		0	0	3	1.5
7	Fluid Mechanics for Petroleum Engineers-Laboratory	PCC		0	0	3	1.5
8	Heat Transfer Operations-Laboratory	PCC		0	0	3	1.5
9	Python programming	SC		1	0	2	2
MC	Environmental Science	MC		2	0	0	0
			Total credits				**21.5**

Category Laboratory	**CREDITS**
Basic Science course	3.0
Professional core Courses	16.5
Skill oriented course	2.0
TOTAL CREDITS	**21.5**

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B.TECH. PETROLEUM ENGINEERING

Semester IV (Second year)

Sl. No.	Course Title	Category	Course Code	Hours per week			Credits
				L	**T**	**P**	
1	Management & Organization behavior	HS		3	0	0	3
2	Mathematics –IV	BS		3	0	0	3
3	Instrumentation, Process Dynamics & Control	PCC		3	0	0	3
4	Thermodynamics for Petroleum Engineers	PCC		3	0	0	3
5	Drilling & Well Completions	PCC		3	0	0	3
6	Instrumentation, Process Dynamics & Control -Laboratory	PCC		0	0	3	1.5
7	Mathematical methods for Petroleum Engineers – Laboratory	PCC		0	0	3	1.5
8	Drilling Fluids – Laboratory	PCC		0	0	3	1.5
9	Industry Exploration Project	SC		1	0	2	2
						Total credits	**21.5**
Internship 2 Months (Mandatory) during summer vacation							
Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)				**4**	0	**0**	**4**

Category	**CREDITS**
Basic Science Courses	3.0
Professional core Courses	13.5
Engineering Science Courses	-
Skill oriented course*	2.0
Humanities and Social Sciences	3.0
TOTAL CREDITS	**21.5**

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B.TECH. PETROLEUM ENGINEERING

Semester V (Third year)

S No	Course Title	Category	Course Code	Hours per week			Credits
				L	**T**	**P**	
1	Petroleum Exploration	PCC		3	0	0	3
2	Well Logging & Formation Evaluation	PCC		3	0	0	3
3	Petroleum Reservoir Engineering-I	PCC		3	0	0	3
4	Open Elective Course/Job oriented Elective (for other branches) i. Introduction to Petroleum Engineering ii. Safety in Petroleum Operations iii. Corrosion Control in Petroleum Industry	OEC		2	0	2	3
5	Professional Elective courses i. Fundamentals of Liquefied Natural Gas. ii. CBM Reservoir Engineering iii. Offshore Drilling	PEC		3	0	0	3
6	Petroleum Reservoir Engineering - Laboratory	PCC		0	0	3	1.5
7	Drilling Simulation – Laboratory	PCC		0	0	3	1.5
8	Soft Computing Techniques	SC		**1**	**0**	**2**	**2**
9	Essence of Indian Traditional Knowledge	MC		2	0	0	0
Summer Internship 2 Months (Mandatory) after second year (to be evaluated during V semester				0	0	0	1.5
						Total credits	**21.5**
Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)				**4**	**0**	**0**	**4**

Category	**CREDITS**
Professional core Courses	12
Professional Elective courses	3
Open Elective Course/Job oriented elective	3
Skill advanced course/ soft skill course*	2
Summer Internship	1.5
TOTAL CREDITS	**21.5**

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B.TECH. PETROLEUM ENGINEERING

Semester VI (Third year)

SNo	Course Title	Category	Course Code	Hours per week			Credits
				L	**T**	**P**	
1	Petroleum Production Engineering	PCC		3	1	0	3
2	Petroleum Reservoir Engineering-II	PCC		3	0	0	3
3	Petroleum Refinery & Petrochemical Engineering	PCC		3	0	0	3
4	Professional Elective courses i. Advanced Well Completion Engineering ii. Applied Mathematics in Reservoir Engineering iii. Natural Gas Hydrates	PEC		3	0	0	3
5	Open Elective Course/Job oriented elective (for other branches) i. Basic concepts in Petroleum Drilling and Completions ii. Basic concepts in Petroleum Production Engineering iii. Basic concepts in Petroleum Reservoir Engineering	OEC		2	0	2	3
6	Petroleum Analysis-Laboratory	PCC		0	0	3	1.5
7	Petroleum Equipment Design & Simulation - Laboratory	PCC		0	0	3	1.5
8	Petroleum Reservoir Simulation-Laboratory	PCC		0	0	3	1.5
9	Data Science	SC		**1**	**0**	**2**	**2**
10	IPR & Patents	MC		2	0	0	0
						Total credits	**21.5**
Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)				**4**	0	0	**4**
Industrial/Research Internship (Mandatory) 2 Months during summer vacation							

Category	**CREDITS**
Professional core courses	13.5
Professional Elective courses	3
Open Elective Course/Job oriented elective	3
Skill advanced course/ soft skill course*	2
Mandatory course (AICTE)	0
Industrial/Research Internship (Mandatory) 2 Months	-
TOTAL CREDITS	**21.5**

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Semester VII (Fourth year)

S.No	Course Title	Category	Course Code	Hours per week			Credits
				L	**T**	**P**	
1	Professional Elective courses i. Design of Surface Facilities ii. Reservoir Modeling & Simulation iii. Subsea Engineering	PEC		3	0	0	3
2	Professional Elective courses i. HSE in Petroleum Industry ii. Well Stimulation iii. Horizontal Well Technology	PEC		3	0	0	3
3	Professional Elective courses i. Petroleum Economics, Policies and Regulations ii. EOR Techniques iii. Asset Management	PEC		3	0	0	3
4	Open Elective Courses (for other branches) i. Transportation of oil and gas ii. Basics concepts in Seismic methods for Hydrocarbon Exploration iii. Basic concepts in Artificial lift methods	OEC		3	0	0	3
5	Open Elective Courses (for other branches) i. Deepwater Technology ii. Basic concepts of acidizing and hydro-fracturing iii. Fundamentals of EOR Techniques	OEC		2	0	2	3
6	Universal Human Values 2: Understanding Harmony			**3**	**0**	**0**	**3**
7	Cloud Computing			1	0	2	2
Industrial/Research Internship after third year (to be evaluated during VII semester				0	0	0	3
						Total credits	**23**
Honors/Minor courses				**4**		**0**	**4**

Category	**CREDITS**
Professional Elective courses	9
Open Elective Course/Job oriented elective	6
Humanities and Social Science Elective	3
Skill advanced course/ soft skill course*	2
Industrial/Research Internship	3

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TOTAL CREDITS	**23**

Semester VIII (Fourth year)

Sl. No.	Category	Code	Course Title	Hours per week			Credits
1	Major Project	PROJ	Project (internship in industry)/ Project (in-house) and seminar.	0	0	0	12
	INTERNSHIP (6 MONTHS)						
			Total credits				**12**

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B. Tech. Chemical Engineering Syllabus, R20 – Regulation

APPENDIX-I

Suggested course list (Department/NPTEL/SWAYAM)-2022 for UG R20 regulation for Honors degree in Petroleum Engineering.

Department of PE & PCE**	
S. No	**Course Name**
1	General geology
2	Drilling fluids and cements
3	Well Testing
4	Advanced reservoir engineering
5	Statistics for petroleum engineers and geoscientists
6	Natural Gas Processing
7	Production optimization using nodal analysis
8	Shale gas engineering
9	Advanced natural gas engineering
10	Reservoir simulation

NPTEL/SWAYAM Portal	
S.No.	**Course Name**
1	Advanced thermodynamics
2	Environmental quality monitoring and analysis
3	Offshore structures under special environmental loads including fire resistance
4	Natural Gas Engineering
5	Upstream Liquefied natural gas technology
6	Computer methods of structural analysis of offshore structures
7	HSE practices for offshore structures and petroleum industries
8	Air pollution and Control
9	Flow through porous media
10	Project management and decision analysis

**These courses will be handled by the department of PE & PCE, if no courses are available for Petroleum Engineering in the NPTEL/SWAYAM portal.

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Department of Petroleum Engineering & Petrochemical Engineering
B. Tech. Chemical Engineering Syllabus, R20 – Regulation

Suggested course list for B. Tech Minor Degree in Petroleum Engineering, 2022

S No	Course Name
1	Petroleum Geology
2	Petroleum Exploration
3	Well Logging & Formation Evaluation
4	Drilling & Well Completions
5	Petroleum Production Engineering
6	Petroleum Reservoir Engineering
7	Surface Production Operations
8	EOR Techniques
9	Unconventional Petroleum Sources
10	HSE in Petroleum Industry

NOTE: The above courses will be handled by the department, as these are not available from the list of NPTEL / SWAYAM portal.

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University College of Engineering Kakinada (A)
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I Year- I Semester

L	T	P	C
3	0	0	3

MATHEMATICS – I

Learning Objectives:

- To familiarize a variety of well-known sequences and series, with a developing intuition about the behaviour of new ones.
- To enlighten the learners in the concept of differential equations and multivariable calculus.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

UNIT – I: Sequences, Series and Mean value theorems: (10 hrs)

Sequences and Series: Convergences and divergence – Ratio test – Comparison tests – Integral test – Cauchy's root test – Alternate series – Leibnitz's rule.

Mean Value Theorems (without proofs): Rolle's Theorem – Lagrange's mean value theorem – Cauchy's mean value theorem – Taylor's and Maclaurin's theorems with remainders, Problems and applications on the above theorem.

UNIT – II: Differential equations of first order and first degree: (10 hrs)

Linear differential equations – Bernoulli's equations – Exact equations and equations reducible to exact form – Homogeneous and Non-homogeneous differential equations of higher order with constant coefficients – with non-homogeneous term of the type e^{ax}, sin ax, cos ax, polynomials in x^n, e^{ax} V(x) and x^nV(x) – Method of Variation of parameters – Euler-Cauchy equation and Legender's equation.

Applications: Orthogonal trajectories – Electrical circuits (RL, RC, RLC) – Simple Harmonic motion.

UNIT – III: Partial differentiation: (10 hrs)

Introduction – Homogeneous function – Euler's theorem – Total derivative – Chain rule – Jacobian – Functional dependence – Taylor's and MacLaurin's series expansion of functions of two variables.

Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

UNIT – IV: Multiple integrals: (8 hrs)

Double integrals – Change of order of integration – Double integrals in polar coordinates – Change of variables to polar coordinates – Areas enclosed by plane curves – Triple integrals – Volume of solids – Change of variables to spherical and cylindrical co-ordinates.

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UNIT – V: Beta and Gamma functions: (5 hrs)

Introduction to Improper Integrals –Beta and Gamma functions – Properties – Relation between Beta and Gamma functions – Evaluation of improper integrals.

Course Outcomes: At the end of the course, the student will be able to

- utilize mean value theorems to real life problems (L3)
- solve the differential equations related to various engineering fields (L3)
- familiarize with functions of several variables which is useful in optimization (L3)
- apply double integration techniques in evaluating areas bounded by region (L3)
- students will also learn important tools of calculus in higher dimensions. Students will become familiar with 2- dimensional and 3-dimensional coordinate systems (L5)
- conclude the use of special function in multiple integrals (L4)

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. B. V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. Joel Hass, Christopher Heil and Maurice D. Weir, Thomas calculus, 14th Edition, Pearson.
3. Lawrence Turyn, Advanced Engineering Mathematics, CRC Press, 2013.

Srimantha Pal, S C Bhunia, Engineering Mathematics, Oxford University Press

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I Year- I Semester

L	T	P	C
3	0	0	3

ENGINEERING PHYSICS

Learning Objectives:

- Bridging the gap between the physics in school at 10+2 level and UG level engineering courses.
- To identify the importance of the optical phenomenon i.e. interference, diffraction and polarization related to its Engineering applications
- Understand the mechanism for emission of light, utility of lasers as coherent light sources for low and high energy applications, study of propagation of light through optical fibers and their implications in optical communications.
- Open new avenues of utility for dielectric and magnetic materials as potential sources for micro devices.
- Familiarize the concepts of theoretical acoustics for their practical utility in engineering acoustics. Explanation for the significance of ultrasound and its application in NDT application.
- Enlighten the periodic arrangement of atoms in Crystalline solids by Bragg's law – Learning the structural analysis through X-ray diffraction.

Unit-I: Wave Optics **10hrs**

Interference: Introduction - Principle of superposition –Interference of light - Interference in thin films (Reflection Geometry) and its applications - Colors in thin films- Newton's Rings- Determination of wavelength and refractive index.

Diffraction: Introduction - Fresnel and Fraunhofer diffraction - Fraunhofer diffraction due to single slit, double slit - N-slits (Qualitative) – Grating - Dispersive power and resolving power of Grating (Qualitative).

Polarization: Introduction-Types of polarization - Polarization by reflection, refraction and Double refraction - Nicol's Prism - Half wave and Quarter wave plates.

Unit Outcomes:

The students will be able to

- **Explain** the need of coherent sources and the conditions for sustained interference (L2)
- **Identify** engineering applications of interference (L3)
- **Analyze** the differences between interference and diffraction with applications (L4)
- **Illustrate** the concept of polarization of light and its applications (L2)
- **Classify** ordinary polarized light and extraordinary polarized light (L2)

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Unit-II: Lasers and Fiber optics **10hrs**

Lasers: Introduction – Characteristics of laser – Spontaneous and Stimulated emissions of radiation – Einstein's coefficients – Population inversion –Lasing action- Pumping Schemes – Ruby laser – He-Ne laser - Applications of lasers.

Fiber optics: Introduction –Principle of optical fiber- Acceptance Angle- Numerical Aperture- Classification of optical fibers based on refractive index profile and modes –Propagation of electromagnetic wave through optical fiber - Applications.

Unit Outcomes:

The students will be able to

- **Understand** the basic concepts of LASER light Sources (L2)
- **Apply** the concepts to learn the types of lasers (L3)
- **Identifies** the Engineering applications of lasers (L2)
- **Explain** the working principle of optical fibers (L2)
- **Classify** optical fibers based on refractive index profile and mode of propagation (L2)
- **Identify** the applications of optical fibers in various fields (L2)

UNITIII: Dielectric and Magnetic Materials **8hrs**

Dielectric Materials: Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility and Dielectric constant - Types of polarizations - Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field - Clausius- Mossotti equation- Piezoelectricity.

Magnetic Materials: Introduction - Magnetic dipole moment - Magnetization- Magnetic susceptibility and permeability - Origin of permanent magnetic moment - Classification of magnetic materials: Dia, para, Ferro, antiferro & Ferrimagnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials.

Unit Outcomes:

The students will be able to

- **Explain** the concept of dielectric constant and polarization in dielectric materials (L2)
- **Summarize** various types of polarization of dielectrics (L2)
- **Interpret** Lorentz field and Claussius- Mosotti relation in dielectrics(L2)
- **Classify** the magnetic materials based on susceptibility and their temperature dependence(L2)
- **Explain** the applications of dielectric and magnetic materials (L2)
- **Apply** the concept of magnetism to magnetic devices (L3)

Unit-IV: Acoustics and Ultrasonics **10hrs**

Acoustics: Introduction – requirements of acoustically good auditorium– Reverberation – Reverberation time – Sabine's formula (Derivation using growth and decay method) - Absorption coefficient and its determination – Factors affecting acoustics of buildings and their remedial measures.

Ultrasonics: Introduction – Characteristics of Ultrasonic waves – Production of ultrasonic waves by magnetostriction and piezoelectric methods – Detection - Acoustic grating - Non Destructive Testing – pulse echo system through transmission and reflection modes - Applications.

Unit Outcomes:

The students will be able to

- **Explain** how sound is propagated in buildings (L2)
- **Analyze** acoustic properties of typically used materials in buildings (L4)
- **Recognize** sound level disruptors and their use in architectural acoustics (L2)
- **Identify** the use of ultrasonics in different fields (L3)

Unit-V: Crystallography and X-ray diffraction **10hrs**

Crystallography: Space lattice, Basis, Unit Cell and lattice parameters – Bravais Lattice – crystal systems (3D) – coordination number - packing fraction of SC, BCC & FCC - Miller indices – separation between successive (hkl) planes.

X- ray diffraction: Bragg's law - X-ray Diffractometer – crystal structure determination by Laue's and powder methods.

Unit Outcomes:

The students will be able to

- **Classify** various crystal systems (L2)
- **Identify** different planes in the crystal structure (L3)
- **Analyze** the crystalline structure by Bragg's X-ray diffractometer (L4)
- **Apply** powder method to measure the crystallinity of a solid (L4)

Outcomes:

CO1 **Explain** the need of coherent sources and the conditions for sustained interference (L2). **Identify** applications of interference in engineering (L3). **Analyze** the differences between interference and diffraction with applications (L4). **Illustrate** the concept of polarization of light and its applications (L2). **Classify** ordinary polarized light and extraordinary polarizedlight (L2) The different realms of physics and their applications in both scientific and technological systems are achieved through the study of wave optics.

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CO2 **Explain** various types of emission of radiation (L2). **Identify** lasers as tools in engineering applications (L3). **Describe** the construction and working principles of various types of lasers (L1). **Explain** the working principle of optical fibers (L2). **Classify the** optical fibers based on refractive index profiles and modes of propagation (L2). **Identify** the applications of optical fibers in medical, communication and other fields (L2). **Apply** the fiber optic concepts in various fields (L3).

CO3 **Explain** the concept of dielectric constant and polarization in dielectric materials (L2). **Summarize** various types of polarization of dielectrics (L2). **Interpret** Lorentz field and Claussius- Mosotti relation in dielectrics (L2). **Classify** the magnetic materials based on susceptibility and their temperature dependence (L2). **Explain** the applications of dielectric and magnetic materials (L2). **Apply** the concept of magnetism to magnetic devices (L3).

CO4 **Explain** sound waves and its propagation/absorption of construction material used in design of buildings (L2). **Analyze** acoustic parameters of typical materials used in buildings (L4). **Recognize** sound level disruptors and their application in architectural acoustics (L2). **Identify** the use of ultrasonics in diversified fields of engineering (L3)

CO5 **Interpret** various crystal systems (L2) and **Analyze** the characterization of materials by XRD (L4). **Identify** the important properties of crystals like the presence of long-range order and periodicity, structure determination using X-ray diffraction technique (L3). **Analysis** of structure of the crystals by Laue's and Powder techniques (L2).

Text books:

1. Engineering Physics by M. N. Avadhanulu, P.G.Kshirsagar & TVS Arun MurthyS.Chand Publications, 11th Edition 2019.
2. Engineering Physics" by D.K.Bhattacharya and Poonam Tandon, Oxford press (2018).
3. Applied Physics by P.K.Palanisamy ,SciTech publications (2018)

Reference Books:

1. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley &Sons, 11th Edition (2018)
2. Engineering Physics by M.R.Srinivasan, New Age international publishers (2014).
3. Engineering Physics by B.K. Pandey and S. Chaturvedi, , Cengage Learning(2018)
4. Engineering Physics - Sanjay D. Jain, D. Sahasrambudhe and Girish, UniversityPress(2016)
5. University Physics by H.D.Young and R.A. Freedman,Pearson(2017)

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I Year- I Semester

L	T	P	C
3	0	0	3

ENGINEERING MECHANICS

Learning Objectives:

The students completing this course are expected to understand the concepts of forces and its resolution in different planes, resultant of force system, Forces acting on a body, their free body diagrams using graphical methods. They are required to understand the concepts of centre of gravity and moments of inertia and their application, Analysis of frames and trusses, different types of motion, friction and application of work - energy method.

UNIT – I:

Objectives: The students are to be exposed to the concepts of force and friction, direction and its application.

Introduction to Engg. Mechanics – Basic Concepts.

Systems of Forces: Coplanar Concurrent Forces – Components in Space – Resultant – Moment of Force and its Application – Couples and Resultant of Force Systems.

Friction: Introduction**,** limiting friction and impending motion, coulomb's laws of dry friction, coefficient of friction, cone of friction

UNIT– II:

Objectives: The students are to be exposed to application of free body diagrams. Solution to problems using graphical methods and law of triangle of forces.

Equilibrium of Systems of Forces: Free Body Diagrams, Lami's Theorm, Equations of Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Equations of Equilibrium for Spatial System of forces, Numerical examples on spatial system of forces using vector approach, Analysis of plane trusses.

UNIT – III:

Objectives: The students are to be exposed to concepts of centre of gravity. The students are to be exposed to concepts of moment of inertia and polar moment of inertia including transfer methods and their applications.

Centroid: Centroids of simple figures (from basic principles) – Centroids of Composite Figures

Centre of Gravity: Centre of gravity of simple body (from basic principles), centre of gravity of composite bodies, Pappus theorems.

Area moments of Inertia: Definition – Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia. **Mass Moment of Inertia:** Moment of Inertia of Masses, Transfer Formula for Mass Moments of Inertia, mass moment of inertia of composite bodies.

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UNIT – IV:

Objectives: The students are to be exposed to motion in straight line and in curvilinear paths, its velocity and acceleration computation and methods of representing plane motion.

Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics- D'Alembert's Principle, Work Energy method and applications to particle motion- Impulse momentum method.

UNIT – V:

Objectives: The students are to be exposed to rigid motion kinematics and kinetics

Rigid body Motion: Kinematics and kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse momentum method.

Course outcomes:

CO1. To Learn the principles (Axioms) of statics, able to find resultant & resolution of system of forces and resultant force.
CO2. Explore the concepts of constraints, free body diagram and action-reaction.
CO3. Estimate the geometric parameters like centroid, center of gravity and moment of inertia and identify their application.
CO4. Learn the analysis of frames and trusses and know the importance of friction.
CO5. Able to determine solution to dynamic problems through D'Alembert equilibrium equations, Impulse-Momentum and work– energy method

Text Book:

1. Engg. Mechanics - S.Timoshenko & D.H.Young., 4th Edn - , Mc Graw Hill publications.

References:

1. Engineering Mechanics statics and dynamics – R.C.Hibbeler, 11th Edn – Pearson Publ.
2. Engineering Mechanics, statics – J.L.Meriam, 6th Edn – Wiley India Pvt Ltd.
3. Engineering Mechanics, dynamics – J.L.Meriam, 6th Edn – Wiley India Pvt Ltd.
4. Engineering Mechanics, statics and dynamics – I.H.Shames, – Pearson Publ.
5. Mechanics For Engineers, statics - F.P.Beer & E.R.Johnston – 5th Edn Mc Graw Hill Publ.
6. Mechanics For Engineers, dynamics - F.P.Beer & E.R.Johnston –5th Edn Mc Graw Hill Publ.
7. Theory & Problems of engineering mechanics, statics & dynamics – E.W.Nelson, C.L.Best & W.G. McLean, 5th Ed – Schaum's outline series - Mc Graw Hill Publ.
8. Engineering Mechanics , Fedinand . L. Singer , Harper – Collins.
9. Engineering Mechanics statics and dynamics , A Nelson , Mc Graw Hill publications
10. Engineering Mechanics, Tayal. Umesh Publ.

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I Year- I Semester

L	T	P	C
3	0	0	3

ELEMENTS OF MECHANICAL ENGINEERING

Learning Objectives:

- The content of this course shall provide the student the basic concepts of various mechanical systems and exposes the student to a wide range of equipment and their utility in a practical situation. It shall provide the fundamental principles of materials, fuels, Steam, I.C. Engines, compressors, hydraulic machines and transmission systems that usually exist in any process plant.

UNIT –I:
Stresses and strains: kinds of – stress-strains, elasticity and plasticity, Hooks law, stress –strain diagrams, modules of elasticity, Poisson's ratio, linear and volumetric strain, relation between E, N, and K, bars of uniform strength, compound bars and temperature stresses.

UNIT–II:
Types of supports – loads – Shear force and bending moment for cantilever and simply supported beams without overhanging for all types of loads.

UNIT-III:
Thin cylindrical shells: stress in cylindrical shells due to internal pressures, circumferential stress, longitudinal stress, design of thin cylindrical shells, spherical shells, change in dimension of the shell due to internal pressure, change in volume of the shell due to internal pressure.
Thick Cylinders: Lame's equation- cylinders subjected to inside and outside pressures columns and Struts.

UNIT-IV:
Steam boilers: Classification of boilers, essentialities of boilers, selection of different types of boilers, study of boilers, boiler mountings and accessories.
Internal combustion engines: classification of IC engines, basic engine components and nomenclature, working principle of engines, Four strokes and two stroke petrol and diesel engines, comparison of CI and SI engines, comparison of four stroke and two stroke engines, simple problems such as indicated power, brake power, friction power, specific fuel consumption, brake thermal efficiency, indicated thermal efficiency and mechanical efficiency.

UNIT-V:
Transmission systems: Belts –Ropes and chain: belt and rope drives, velocity ratio, slip, length of belt , open belt and cross belt drives, ratio of friction tensions, centrifugal tension in a belt, power transmitted by belts and ropes, initial tensions in the belt, simple problems.

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Outcomes:
After completing the course, the student shall be able to determine:

- The stress/strain of a mechanical component subjected to loading.
- The performance of components like Boiler, I.C. Engine, Compressor, Steam/Hydraulic turbine, Belt, Rope and Gear.
- The type of mechanical component suitable for the required power transmission.

Text Books:

1. Strength of Materials and Mechanics of Structures, B.C.Punmia, Standard Publications and distributions, 9 th Edition, 1991.
2. Thermal Engineering, Ballaney,P.L., Khanna Publishers, 2003.
3. Elements of Mechanical Engineering, A.R.Asrani, S.M.Bhatt and P.K.Shah, B.S. Publs**.**
4. Elements of Mechanical Engineering, M.L.Mathur, F.S.Metha&R.P.Tiwari Jain Brothers Publs., 2009**.**

Reference Book:

1. Theory of Machines, S.S. Rattan, Tata McGraw Hil., 2004 & 2009.

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I Year- I Semester

L	T	P	C
3	0	0	3

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

Learning Objectives:

UNIT - 1 Electrical Circuits

Basic definitions – types of network elements – Ohm's Law – Kirchhoff's Laws – Resistive networks – Inductive networks – Capacitive networks – series – parallel circuits – Mesh and Node Analysis – star-delta and delta-star transformations – simple Numerical Problems.

UNIT - 2 DC Machines

Principle of operation of DC generator – EMF equation – open circuit characteristics of separately excited DC shunt Generator - types of DC machines – Principle of operation of DC Motor - torque equation – three point starter – speed control methods of DC motor – Swinburne's Test- simple Numerical Problems.

UNIT - 3 Transformers

Construction and Principle of operation of single phase transformers – EMF equation – Losses – OC & SC tests w.r.t. efficiency and regulation only - simple Numerical Problems.

AC Rotating Machines

Alternators: Construction and Principle of operation of alternators – Regulation of alternator by synchronous impedance method.

3-Phase induction motor : principle of operation of 3-Phase induction motor – slip-torque characteristics – simple Numerical Problems.

UNIT - 4 Rectifiers

Operation of PN junction diodes and their characteristics – Rectifiers: Operation of half wave and full wave rectifiers – relevant wave forms – Derivation of output voltage and efficiency - simple Numerical Problems.

UNIT - 5 Transistors

Operation of PNP and NPN junction transistors, transistor configurations – input output characteristics, transistor as an amplifier in CE arrangement, – frequency response of CE amplifier.

Course Outcomes: At the end of the course, student will be able to

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CO1 Analyse various electrical networks.

CO2 Understand operation of DC generators,3-point starter and DC machine testing by Swinburne's Test.

CO3 Analyse performance of single-phase transformer.

CO4 Explain operation of 3-phase alternator and 3-phase induction motors.

CO5 Analyse operation of half wave, full wave bridge rectifiers, transistor configurations and frequency response of CE amplifier.

#*Based on suggested Revised BTL*

Text Books:

1. Electrical Technology by Surinder Pal Bali, Pearson Publications.
2. Electronic Devices and Circuits by R.L. Boylestad and Louis Nashelsky, 9th edition, PEI/PHI 2006.

Reference Books:

1. Electrical Circuit Theory and Technology by John Bird, Routledge Taylor &Francis Group.
2. Basic Electrical Engineering by M.S.Naidu and S.Kamakshiah, TMH Publications
3. Fundamentals of Electrical Engineering by Rajendra Prasad, PHI Publications,2nd edition
4. Basic Electrical Engineering by Nagsarkar, Sukhija, Oxford Publications,2nd edition
5. Industrial Electronics by G.K. Mittal, PHI

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I Year- I Semester	**L**	**T**	**P**	**C**
	0	**0**	**3**	**1.5**

ENGINEERING WORKSHOP AND IT WORKSHOP

ENGINEERING WORKSHOP:

Learning Objectives: To impart hands-on practice on basic engineering trades and skills.

Note: At least two exercises to be done from each trade.

Trade:

1.Carpentry
1. T-Lap Joint
2. Cross Lap Joint
3. Dovetail Joint
4. Mortise and Tenon Joint

2.Fitting
1. Vee Fit
2. Square Fit
3. Half Round Fit
4. Dovetail Fit

3.Black Smithy
1. Round rod to Square
2. S-Hook
3. Round Rod to Flat Ring
4. Round Rod to Square headed bolt

4.House Wiring
1. Parallel / Series Connection of three bulbs
2. Stair Case wiring
3. Florescent Lamp Fitting
4. Measurement of Earth Resistance

5.Tin Smithy
1. Taper Tray
2. Square Box without lid
3. Open Scoop
4. Funnel

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IT WORKSHOP:

Objectives:

- **PC Hardware:** Identification of basic peripherals, Assembling a PC, Installation of system software like MS Windows, device drivers, etc. Troubleshooting of PC Hardware and Software issues.
- **Internet & World Wide Web:** Different ways of hooking the PC on to the internet from home and workplace and effectively usage of the internet, web browsers, email, newsgroups and discussion forums. Awareness of various threats on the Internet and its solutions
- **Productivity Tools:** Understanding and practical approach of professional word documents, excel spread sheets, power point presentations and personal web sites using the Microsoft suite office tools.

Course Outcomes:

List of Exercises:

Note: Faculty to consolidate the workshop manuals using the textbook and references

Task 1: Identification of the peripherals of a computerand its functionality.

Task 2: Prepare a report containing the block diagram of the computer.

Task 3: Describe about various I/O Devices and its usage.

Task 4: Practicingdisassembling and assembling components of a PC

Task 5: Installation of Device Drivers, MS windows, Linux Operating systems and Disk Partitioning

Task 6: Introduction to Memory and Storage Devices, I/O Port, Assemblers, Compilers, Interpreters, Linkers and Loaders.

Task 7: Demonstration of Hardware Troubleshooting

Task 8: Demonstration of Software Troubleshooting

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Task 9: Demonstrating on Importance of Networking, Types of Networks Transmission Media and Various Networking Devices.

Task 10: Search Engines & Netiquette: Students should know what search engines are and how to use the search engines. Usage of search engines like Google, Yahoo, ask.com and others should be demonstrated by student.

Task 11:Awareness of various threats on the Internet and its solutions

Task 12: Demonstration and Practice on Microsoft Word

Task 13: Demonstration and Practice on Microsoft Excel

Task 14: Demonstration and Practice on Microsoft Power Point

TEXT BOOK:

1 Computer Fundamentals, Anita Goel, Pearson India Education, 2017

REFERENCE BOOK:

1. Essential Computer and IT Fundamentals for Engineering and Science Students, Dr. N. B. Venkateswarlu, S. Chand Publishers
2. Comdex Information Technology, Vikas Gupta, Dreamtech.

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I Year- I Semester	**L**	**T**	**P**	**C**
	0	**0**	**3**	**1.5**

ENGINEERING PHYSICS – LABORATORY

Learning Objectives:

NOTE: (Any 10 of the following listed experiments)
List of Engineering Physics Experiments:

1. Laser: Determination of wavelength using diffraction grating.
2. Young's modulus of given material by Strain gauge method.
3. Study of variation of magnetic field along the axis of a current carrying circular coil by Stewart & Gee's method.
4. Determination of ultrasonic velocity in given liquid (Acoustic grating).
5. Determination of dielectric constant using charging and discharging method.
6. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
7. Estimation of Planck's constant using photoelectric effect.
8. Determination of Rigidity modulus of material of a wire-dynamic method (Torsional pendulum).
9. Determination of numerical aperture and acceptance angle of an optical fiber.
10. Determination of thickness of thin object by wedge method.
11. Determination of radius of curvature of given plano convex lens by Newton's rings.
12. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
13. Determination of the resolving power of telescope.
14. Sonometer: Verification of laws of string.
15. Determination of Acceleration due to gravity and Radius of gyration using Compound pendulum.

Outcomes:

Reference:

1. S. Balasubramanian, M.N. Srinivasan "A Text book of Practical Physics"- S. Chand Publishers, 2017.

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I Year- I Semester

L	T	P	C
0	0	3	1.5

BASIC ENGINEERING (MECHANICAL & ELECTRICAL) LABORATORY

Any SIX experiments from each section
Section A: Mechanical Engineering:

Learning Objectives:

- To impart practical exposure on the performance evaluation methods of various mechanical components like, I. C. Engine, Hydraulic turbine, hydraulic pump, Air compressor etc. and also understand the various processes that can be performed on a lathe machine.

List of Experiments:

1. Draw the valve timing diagram of a 4-stroke diesel engine and port timing diagram of a 2-stroke petrol engine.
2. Perform load test on a 4-stroke C.I. Engine and draw the performance curves.
3. Pattern design and making – for one casting drawing.
4. Taper turning and thread cutting on a Lathe machine.
5. Performance on an Impulse/Reaction Hydraulic Turbine.
6. Performance of Centrifugal/Reciprocating Pump.
7. Find the volumetric efficiency, isothermal efficiency of an Air compressor.

Outcomes:

- The student will be able to predict the performance of several mechanical components and operate a lathe machine to produce the required job work.

Section B: Electrical Engineering:

Learning Objectives:
The following experiments are required to be conducted as compulsory experiments from each section:

1. Open Circuit Characteristics of separately excited DC Shunt Generator
2. Swinburne's test on D.C. Shunt machine (predetermination of efficiency of a given D.C. shunt machine working as motor and generator).
3. Speed control of D.C. Shunt motor by Armature Voltage control and Field control methods
4. OC and SC tests on single phase transformer (predetermination of efficiency and regulation at given power factors).

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5. Brake test on 3-phase Induction motor (determination of performance characteristics)
6. Regulation of alternator by Synchronous impedance method.

Course Outcomes: At the end of the course, student will be able to

CO1 To obtain Open Circuit Characteristics of DC shunt generator.

CO2 To predetermine the efficiency of dc shunt machine using Swinburne's test.

CO3 To control speed of dc shunt motor using Armature voltage and Field control methods.

CO4 To predetermine the efficiency and regulation of single-phase transformer with O.C and S.C tests.

CO5 To obtain performance characteristics of a 3-phase induction motor.

I Year- I Semester

L	T	P	C
0	0	2	0

PHYSICS VIRTUAL LABORATORY

Learning Objectives:

Note: Any 5 of the following listed 10 experiments

List of Experiments:

1. Hall Effect
2. Brewster's angle
3. Numerical Aperture of Optical fiber
4. Photoelectric Effect
5. Michelson's interferometer
6. Newton's rings –Refractive index of liquid
7. Dispersive power of a prism
8. Resolving power of the prism
9. Magnetic susceptibility by Quincke's method
10. Velocity sound waves by Kundt's tube

Outcomes:

URL: www.vlab.co.in

I Year- I Semester

L	T	P	C
3	0	0	0

CONSTITUTION OF INDIA
(MC)

Learning Objectives:

- To Enable the student to understand the importance of constitution
- To understand the structure of executive, legislature and judiciary
- To understand philosophy of fundamental rights and duties
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
- To understand the central and state relation financial and administrative.

UNIT-I:

Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

Learning outcomes:

After completion of this unit student will

- Understand the concept of Indian constitution
- Apply the knowledge on directive principle of state policy
- Analyze the History, features of Indian constitution
- Evaluate Preamble Fundamental Rights and Duties

UNIT-II:

Union Government and its Administration Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, LokSabha, RajyaSabha, The Supreme Court and High Court: Powers and Functions;

Learning outcomes:-After completion of this unit student will

- Understand the structure of Indian government
- Differentiate between the state and central government
- Explain the role of President and Prime Minister
- Know the Structure of supreme court and High court

UNIT-III:

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

Learning outcomes:-After completion of this unit student will

- Understand the structure of state government
- Analyze the role Governor and Chief Minister
- Explain the role of state Secretariat
- Differentiate between structure and functions of state secretariat

UNIT-IV:

A.Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions PRI: ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

Learning outcomes:-After completion of this unit student will

- Understand the local Administration
- Compare and contrast district administration role and importance
- Analyze the role of Myer and elected representatives of Municipalities
- Evaluate Zillapanchayat block level organisation

UNIT-V

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission:, Functions of Commissions for the welfare of SC/ST/OBC and women

Learning outcomes:- After completion of this unit student will

- Know the role of Election Commission apply knowledge
- Contrast and compare the role of Chief Election commissioner and commissiononerate.
- Analyze role of state election commission
- Evaluate various commissions of viz SC/ST/OBC and women

Outcomes:

At the end of the semester/course, the student will be able to have a clear knowledge on the following:

- Understand historical background of the constitution making and its importance for building a democratic India.
- Understand the functioning of three wings of the government ie., executive, legislative and judiciary.
- Understand the value of the fundamental rights and duties for becoming good citizen of India.
- Analyze the decentralization of power between central, state and local self-government.
- Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.

1. Know the sources, features and principles of Indian Constitution.
2. Learn about Union Government, State government and its administration.
3. Get acquainted with Local administration and Pachayati Raj.
4. Be aware of basic concepts and developments of Human Rights.
5. Gain knowledge on roles and functioning of Election Commission

References:

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1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi
2. SubashKashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government andPolitics Hans
7. J. Raj IndianGovernment and Politics
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

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I Year- II Semester

L	T	P	C
3	0	0	3

MATHEMATICS – II

Learning Objectives:

- To instruct the concept of Matrices in solving linear algebraic equations
- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

UNIT – I: Solving systems of linear equations, Eigen values and Eigen vectors: (10 hrs)

Rank of a matrix by echelon form and normal form – Solving system of homogeneous and non-homogeneous linear equations – Gauss Elimination method – Eigen values and Eigen vectors and properties (article-2.14 in text book-1).
Applications: Fee vibration of two mass system.

Unit – II: Cayley–Hamilton theorem and Quadratic forms: (10 hrs)

Cayley-Hamilton theorem (without proof) – Applications – Finding the inverse and power of a
matrix by Cayley-Hamilton theorem – Reduction to Diagonal form – Quadratic forms and nature of the quadratic forms – Reduction of quadratic form to canonical forms by orthogonal transformation.
Singular values of a matrix, singular value decomposition (text book-3).

UNIT – III: Iterative methods: (8 hrs)

Introduction – Solutions of algebraic and transcendental equations: Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations)
Solutions of system of equations – Jacobi and Gauss -Seidel methods
Evaluation of largest eigen value – eigen vector using Power Method .

UNIT – IV: Interpolation: (10 hrs)

Introduction – Errors in polynomial interpolation – Finite differences – Forward differences – Backward differences – Central differences – Relations between operators – Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula – Newton's divide difference formula.

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UNIT – V: Numerical differentiation and integration, Solution of ordinary differential equations with initial conditions: (10 hrs)
Numerical differentiation using interpolating polynomial – Trapezoidal rule – Simpson's $1/3^{rd}$ and $3/8^{th}$ rule – Solution of initial value problems by Taylor's series – Picard's method of successive approximations – Euler's method – Runge-Kutta method (second and fourth order) – Milne's Predictor and Corrector Method.

Outcomes: At the end of the course, the student will be able to
- develop the use of matrix algebra techniques that is needed by engineers for practical applications (L6)
- solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Seidel (L3)
- evaluate the approximate roots of polynomial and transcendental equations by different algorithms (L5)
- apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals (L3)
- apply numerical integral techniques to different Engineering problems (L3)
- apply different algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations (L3)

Text Books:
1. B. S. Grewal, Higher Engineering Mathematics, 44^{th} Edition, Khanna Publishers.
2. B. V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.
3. David Poole, Linear Algebra- A modern introduction, 4^{th} Edition, Cengage.

Reference Books:
1. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineering and Science, Tata Mc. Graw Hill Education.
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publications.
3. Lawrence Turyn, Advanced Engineering Mathematics, CRC Press.

ANNEXURE-II

UNIVERSITY COLLEGE OF ENGINEERING
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

I B. Tech. ENGINEERING CHEMISTRY (Non-circuit branches)

Knowledge of basic concepts of Chemistry for Engineering students will help them as professional engineers later in design and material selection, as well as utilizing the available resources.

Learning Objectives:

- ***Importance*** of usage of plastics in household appliances and composites (FRP) in aerospace and automotive industries.
- ***Outline*** the basics for the construction of electrochemical cells, batteries and fuel cells. Understand the mechanism of corrosion and how it can be prevented.
  Express the increase in demand as wide variety of advanced materials are introduced; which have excellent engineering properties.
  Classify and discuss the materials used in major industries like steel industry, metallurgical industries and construction industries and electrical equipment manufacturing industries. Lubrication is also ***summarized***.
- ***Relate*** the need of fuels as a source of energy to any industry, particularly industries like thermal power stations, steel industry, fertilizer industry etc., and hence introduced.
- ***Explain*** the importance and usage of water as basic material in almost all the industries; ***interpret*** drawbacks of steam boilers and also how portable water is supplied for drinking purposes.

UNIT I: POLYMER TECHNOLOGY

Polymerisation:- Introduction-methods of polymerization (emulsion and suspension)-physical and mechanical properties.

Plastics: Compounding-fabrication (compression, injection, blown film, extrusion) - preparation, properties and applications of PVC, polycarbonates and Bakelite-mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste.

Elastomers:- Natural rubber-drawbacks-vulcanization-preparation, properties and applications of synthetic rubbers (Buna S, thiokol and polyurethanes).

Composite materials: Fiber reinforced plastics-conducting polymers-biodegradable polymers-biopolymers-biomedical polymers.

Learning Outcomes: ***At the end of this unit, the students will be able to***

- ***Outline*** the properties of polymers and various additives added and different methods of forming plastic materials.
- ***Explain*** the preparation, properties and applications of some plastic materials.
- ***Interpret*** the mechanism of conduction in conducting polymers .
- ***Discuss*** natural and synthetic rubbers and their applications.

UNIT II: ELECTROCHEMICAL CELLS AND CORROSION

Single electrode potential-Electrochemical series and uses of series-standard hydrogen electrode, calomel electrode-concentration cell-construction of glass electrode-Batteries: Dry cell, Ni-Cd cells, Ni-Metal hydride cells, Li ion battery, zinc air cells-Fuel cells: H_2-O_2, CH_3OH-O_2, phosphoric acid, molten carbonate.

Corrosion:-Definition-theories of corrosion (chemical and electrochemical)-galvanic corrosion, differential aeration corrosion, stress corrosion, waterline corrosion-passivity of metals-galvanic series-factors influencing rate of corrosion-corrosion control (proper designing, cathodic protection)-Protective coatings: Surface preparation, cathodic and anodic coatings, electroplating, electroless plating (nickel). Paints (constituents, functions, special paints).

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Learning Outcomes: ***At the end of this unit, the students will be able to***

- ***Explain*** the theory of construction of battery and fuel cells.
- ***Categorize*** the reasons for corrosion and study some methods of corrosion control.

UNIT III: CHEMISTRY OF MATERIALS

Part- A:

Nano materials:- Introduction-sol-gel method-characterization by BET, SEM and TEM methods-applications of graphene-carbon nanotubes and fullerenes:Types, preparation and applications

Thermal analysis techniques: Instrumentation and applications of thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC).

Part-B:

Refractories: - Definition, classification, properties (refractoriness, refractoriness under load, porosity and thermal spalling), failure of refractories.

Lubricants: - Definition, mechanism of lubricants and properties (definition and importance).

Cement: - Constituents, manufacturing, parameters to characterize the clinker formation: lime saturation factor (LSF), silica ratio (SR) and alumina ratio (AR), chemistry of setting and hardening, deterioration of cement.

Learning Outcomes: ***At the end of this unit, the students will be able to***

- ***Outline*** the awareness of materials like nanomaterials and fullerenes and their uses.
- ***Explain*** the techniques that detect and measure changes of state of reaction.
- ***Illustrate*** the commonly used industrial materials.

UNIT IV: FUELS

Introduction-calorific value-HCV and LCV-problems using Dulong's formula-proximate and ultimate analysis of coal sample-significance of these analyses-problems-Petroleum (refining-cracking)-Synthetic petrol (Fischer Tropsch and Bergius)-petrol knocking-diesel knocking-octane and cetane ratings-anti-knock agents-Introduction to alternative fuels (Bio-diesel, ethanol, methanol, Natural gas, LPG, CNG)-Flue gas analysis by Orsat apparatus-Rocket fuels.

Learning Outcomes: ***At the end of this unit, the students will be able to***

- ***Differentiate*** petroleum, petrol, synthetic petrol and have knowledge how they are produced.
- ***Study*** alternate fuels.
- ***Analyse*** flue gases.

UNIT V: WATER TECHNOLOGY

Hardness of water-determination of hardness by complexometric method-boiler troubles (priming and foaming, scale formation, boiler corrosion, caustic embrittlement)-internal treatments-softening of hard water (zeolite processs and related sums, ion exchange process)-treatment of industrial waste water Portable water and its specifications-steps involved in purification of water-chlorination, break point chlorination-reverse osmosis and electro dialysis.

Learning Outcomes: ***At the end of this unit, the students will be able to***

- ***Explain*** the impurities present in raw water, problems associated with them and how to avoid them are understood.

Text Books:

1. Engineering Chemistry by Jain and Jain; Dhanpat Rai Publicating Co. Latest edition
2. Engineering Chemistry by Shikha Agarwal; Cambridge University Press, 2019 edition.

Reference Books:

1. A text book of engineering Chemistry by S. S. Dara; S. Chand & Co Ltd., Latest Edition
2. Engineering Chemistry by Shashi Chawla; Dhanpat Rai Publicating Co. Latest edition

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I Year- II Semester	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

COMMUNICATIVE ENGLISH

Introduction
The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from *learning about the language* to *using the language*. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

Learning Objectives:
- ➢ Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
- ➢ Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
- ➢ Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
- ➢ Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
- ➢ Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

UNIT-1:

Lesson-1: A Drawer full of happiness from "**Infotech English**", Maruthi Publications

Lesson-2: Deliverance by Premchand from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Listening to short audio texts and identifying the topic. Listening to prose, prose and conversation.
Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests. Self introductions and introducing others.

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Reading: Skimming text to get the main idea. Scanning to look for specific pieces of information.
Reading for Writing: Paragraph writing (specific topics) using suitable cohesive devices; linkers, sign posts and transition signals; mechanics of writing - punctuation, capital letters.
Vocabulary: Technical vocabulary from across technical branches (20) GRE Vocabulary (20) (Antonyms and Synonyms, Word applications) Verbal reasoning and sequencing of words.
Grammar: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countables and uncountables; singular and plural basic sentence structures; simple question form - who-questions; word order in sentences.
Pronunciation: Vowels, Consonants, Plural markers and their realizations

UNIT 2:

Lesson-1: Nehru's letter to his daughter Indira on her birthday from "**Infotech English**", Maruthi Publications

Lesson-2: Bosom Friend by Hira Bansode from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts, both in speaking and writing.
Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks. Functional English: Greetings and leave takings.
Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.
Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.
Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary Analogies (20 words) (Antonyms and Synonyms, Word applications)
Grammar: Use of articles and zero article; prepositions.
Pronunciation: Past tense markers, word stress-di-syllabic words

UNIT 3:
Lesson-1: Stephen Hawking-Positivity 'Benchmark' from "**Infotech English**", Maruthi Publications

Lesson-2: Shakespeare's Sister by Virginia Woolf from "**The Individual Society",** Pearson Publications. (Non-detailed**)**

Listening: Listening for global comprehension and summarizing what is listened to, both in speaking and writing.
Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed. Functional English: Complaining and Apologizing.

Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension. Critical reading.
Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. Letter writing-types, format and principles of letter writing. E-mail etiquette, Writing CV's.
Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Association, sequencing of words
Grammar: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.
Pronunciation: word stress-poly-syllabic words.

UNIT 4:
Lesson-1: Liking a Tree, Unbowed: Wangari Maathai-biography from "**Infotech English**", Maruthi Publications

Lesson-2: Telephone Conversation-Wole Soyinka from "**The Individual Society",** Pearson Publications**.** (Non-detailed)

Listening: Making predictions while listening to conversations/ transactional dialogues without video (only audio); listening to audio-visual texts.
Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions. Functional English: Permissions, Requesting, Inviting.
Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicative process or display complicated data.
Reading for Writing: Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. Writing SOP, writing for media.
Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Cloze Encounters.
Grammar: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms
Pronunciation: Contrastive Stress

UNIT 5:
Lesson-1: Stay Hungry-Stay foolish from "**Infotech English**", Maruthi Publications

Lesson-2: Still I Rise by Maya Angelou from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Identifying key terms, understanding concepts and interpreting the concepts both in speaking and writing.

Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides. Functional English: Suggesting/Opinion giving.
Reading: Reading for comprehension. RAP Strategy Intensive reading and Extensive reading techniques.
Reading for Writing: Writing academic proposals- writing research articles: format and style.
Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Coherence, matching emotions.
Grammar: Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)
Pronunciation: Stress in compound words

Outcomes:
At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information
- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms

Text Books:
Prescribed text books for theory for Semester-I:
1. "Infotech English", Maruthi Publications. (Detailed)
2. "The Individual Society", Pearson Publications. (Non-detailed)

Prescribed text book for Laboratory for Semesters-I & II:
1. "Infotech English", Maruthi Publications. (with Compact Disc)

Reference Books:
1. Bailey, Stephen. Academic writing: A handbook for international students. Routledge, 2014.
2. Chase, Becky Tarver. Pathways: Listening, Speaking and Critical Thinking. Heinley ELT; 2nd Edition, 2018.
3. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
4. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012.

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I Year- II Semester	**L**	**T**	**P**	**C**
	1	**0**	**4**	**3**

ENGINEERING DRAWING

Learning Objectives:

Engineering drawing being the principal method of communication for engineers, the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

UNIT – I:

Objective: To introduce the students to use drawing instruments and to draw polygons, Engg. Curves.

Polygons: Constructing regular polygons by general methods, inscribing and describing polygons on circles.

Curves: Parabola, Ellipse and Hyperbola by general and special methods, cycloids, involutes, tangents & normals for the curves.

Scales: Plain scales, diagonal scales and vernier scales.

UNIT – II:

Objective: To introduce the students to use orthographic projections, projections of points & simple lines. To make the students draw the projections of the lines inclined to both the planes.

Orthographic Projections: Reference plane, importance of reference lines, projections of points in various quadrants, projections of lines, line parallel to both the planes, line parallel to one plane and inclined to other plane.

UNIT – III:

Objective: To make the students draw the projections of the lines inclined to both the planes.

Part-A: Projections of straight lines inclined to both the planes,

Part-B: determination of true lengths of a line inclined to the both the planes, angle of inclination and traces.

UNIT – IV:

Objective: The objective is to make the students draw the projections of the plane inclined to both the planes. The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes

Projections of planes: regular planes perpendicular/parallel to one reference plane and inclined to the other reference plane; inclined to both the reference planes.

Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to one of the planes.

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UNIT – V:

Objective: The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.

Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

Course Outcome: After undergoing this course, the student learnt the scales, various engineering curves and drawing the 2D & 3D objects.

Text Books:

1. Engineering Drawing by N.D. Butt, Chariot Publications
2. Engineering Drawing by Agarwal & Agarwal, Tata McGraw Hill Publishers

Reference Books:

1. Engineering Drawing by K.L.Narayana & P. Kannaiah, Scitech Publishers
2. Engineering Graphics for Degree by K.C. John, PHI Publishers
3. Engineering Graphics by PI Varghese, McGrawHill Publishers
4. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age

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I Year- II Semester	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

PROGRAMMING FOR PROBLEM SOLVING USING – C

Learning Objectives:

UNIT – I:
Problem Solving: Problem solving aspects, problem solving techniques, computer as a problem solving tool, Characteristics of Complex problem Solving methods, Collective Problem Solving, Collaborative Problem Solving, Software Development Life Cycle, algorithms-definition, features, criteria, Flowchart definition, basic symbols, sample flowcharts, Top down design, Implementation of program verification.

UNIT – II:
Basics of C Programming Language: Introduction to C, Structure of a C program, Basic data types and sizes, constants, variables, Unary, Binary and Ternary operators, Expressions, Type conversions, Conditional Expressions, Precedence and Order of Evaluation, Input and Output Statements, Header files, C pre-processors, sample programs. **Selection or Branching:** Simple if, if-else, nested if, if-else ladder and switch-case, goto, break and continue statements. **Iterative or Looping:** While loop, Do-while loop and for loop, sample programs.

UNIT – III:
Functions: Basics, Parameter passing, storage classes, scope rules, block structure, user-defined functions, standard library functions, Recursive functions, Recursive solutions for Fibonacci series and Towers of Hanoi. **Arrays:** Declaration, definition, Accessing elements, types of Arrays, Array applications, Matrix operations, passing 1-D Arrays and 2-D Arrays to functions.
Strings: Basics, string operations, string manipulation functions.

UNIT – IV:
Pointers: Basics, Initialization of Pointer variables, Pointers and function arguments, passing by Address Dangling memory, Address Arithmetic, character pointers and functions. Pointer to Pointer, Pointers and Multi-Dimensional Arrays, Dynamic Memory Management functions, Command-line Arguments.
Notations: The efficiency of algorithms, Analysis of Algorithms, computational complexity of algorithms, order(O), notation, Worst-case and Average-case analysis.

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UNIT – V:

Enumerated, Structure and Union Types: Derived Types, Structure declaration, definition and initialization, accessing Structures, nested Structures, Arrays of Structures, Structures and Functions, Pointers to Structures, Self-referential Structures, Unions, typedef, bit-fields, program applications.

File Handling: Concepts of Files, Text files and Binary Files, formatted I/O, File I/O operations.

Outcomes: At the end of the course, student will be able to

- **CO1** Develop efficient algorithm for solving a problem.
- **CO2** Experiment with various constructs of C programming language efficiently.
- **CO3** Develop programs using modular approach such as functions and also able to develop programs to perform matrix and mathematical applications.
- **CO4** Examine dynamic memory management, problems using pointers and solving the problems.
- **CO5** Develop programs for real-life applications using Structures and also learn about handling the files for storing the data permanently.

Text Books:

1. How to Solve it by Computer, R.G.Dromey, Pearson Education, 2019.
2. Programming in C, Ashok N Kamthane, Amit Ashok Kamthane, 3rd Edition, Pearson Education, 2019.

Reference Books:

1. The C Programming Language by Dennis Richie and Brian Kernighan.
2. Programming in C, Reema Thareja, OXFORD.

C Programming, A Problem Solving Approach, Forouzan, Gilberg, Prasad, Cengage.

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I Year- II Semester	**L**	**T**	**P**	**C**
	0	**0**	**3**	**1.5**

ENGLISH COMMUNICATION SKILLS – LABORATORY

Learning Objectives:

TOPICS

UNIT I:
Vowels, Consonants, Pronunciation, Phonetic Transcription, Common Errors in Pronunciation,

UNIT II:
Word stress-di-syllabic words, poly-syllabic words, weak and strong forms, contrastive stress (Homographs)

UNIT III:
Stress in compound words, rhythm, intonation, accent neutralization.

UNIT IV:
Listening to short audio texts and identifying the context and specific pieces of information to answer a series of questions in speaking.

UNIT V:
Newspapers reading; Understanding and identifying key terms and structures useful for writing reports.

Prescribed text book: "**Infotech English**", Maruthi Publications.

References:

1. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
2. English Pronunciation in use- Mark Hancock, Cambridge University Press.
3. English Phonetics and Phonology-Peter Roach, Cambridge University Press.
4. English Pronunciation in use- Mark Hewings, Cambridge University Press.
5. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
   English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.

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UNIVERSITY COLLEGE OF ENGINEERING
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

COURSE CODE	APPLIED CHEMISTRY/ENGINEERING CHEMISTRY LAB	CATEGORY	3-0-0	1.5

Introduction to Chemistry laboratory – Molarity, normality, primary, secondary standard solutions, volumetric titrations, qualitative analysis

1. Determination of HCl using standard Na_2CO_3 solution
2. Determination of alkalinity of a sample containing Na_2CO_3 and NaOH
3. Determination of Mn (II) using standard oxalic acid solution.
4. Determination of ferrous iron using standard $K_2Cr_2O_7$ solution.
5. Determination of copper (II) using standard hypo solution.
6. Determination of temporary and permanent hardness of water using standard EDTA solution
7. Determination of iron (II) by a colorimetric method.
8. Determination of the concentration of acetic acid using sodium hydroxide (pH metry method)
9. Determination of the concentration of strong acid vs strong base (by conductometric method).
10. Determination of strong acid vs strong base (by potentiometric method)
11. Determination of Mg^{+2} present in an antacid.
12. Determination of $CaCO_3$ present in an egg shell.
13. Estimation of Vitamin C.
14. Determination of phosphoric content in soft drinks.
15. Adsorption of acetic acid by charcoal.
16. Preparation of nylon-6, 6 and Bakelite (demonstration only).

Of the above experiments at-least 10 assessment experiments should be completed in a semester.

Outcomes: The students entering into the professional course have practically very little exposure to lab classes. The experiments introduce volumetric analysis: redox titrations with different indicators, EDTA titrations; then they are exposed to a few instrumental methods of chemical analysis. Thus at the end of the lab course, the student is exposed to different methods of chemical analysis and use of some commonly employed instruments. They has acquire some experimental skills.

Reference Books

1. A Textbook of Quantitative Analysis, Arthur I. Vogel

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I Year- II Semester	**L**	**T**	**P**	**C**
	0	**0**	**3**	**1.5**

PROGRAMMING FOR PROBLEM SOLVING USING - C LABORATORY

Learning Objectives:
- Understand Algorithm and Syntax create Mathematical Operations in C.
- Handle Strings and Files in C.
- Understand Arrays, Pointers and Recursion in C.
- Implement Dynamic and Modular programming in C
- Learn Functions and Storage classes in C.

List of Exercises:

Exercise 1:
a. Write a C program to calculate the area of a triangle.
b. Write a C program to find the largest of three numbers using ternary operator.
c. Write a C program to swap two numbers without using temporary variable.

Exercise 2:
a. Write a C program to find the 2's complement of a binary number.
b. Write a C program to find the roots of a quadratic equation.
c. Write a C program to implement simple calculator using switch statement.

Exercise 3:
a. Write a C program to find the sum of individual digits of a positive integer and also find the reverse of the given number.
b. Write a C program to generate the first n terms of the Fibonacci sequence.
c. Write a C program to generate all the prime numbers between 1 and n,where n is a value supplied by the user.

Exercise 4:
a. Write a C program to print the Multiplication table of a given number.
b. Write a C program to read a decimal number and find it's equivalent binary number.
c. Write a C program to check whether the given number is Armstrong number or not.

Exercise 5:
a. Write a C program to interchange the largest and smallest numbers in the given array.
b. Write a C program to implement Towers of Hanoi.

Exercise 6:
a. Write a C program to implement sorting an array of elements.

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b. Write a C program to implement matrix addition and multiplication.
c. Write a C program to print the upper case matrix using Arrays.

Exercise 7:
Write a C program that uses functions to perform the following operations.
a. To insert a sub string into given main string at a given position.
b. To delete n characters from a given position in a given string.
c. To replace a character of a string either from beginning or ending or at a specified location.

Exercise 8:
Write a C program that uses functions to perform the following operations using Structure:
a. Reading a complex number
b. Writing a complex number
c. Addition of two complex numbers
d. Multiplication of two complex numbers

Exercise 9:
Write a C program for the following string operations without using the built-in functions.
a. To concatenate two strings
b. To append a string to another string
c. To compare two strings

Exercise 10:
a. Write a C program to find the number of characters in a given string including and excluding spaces.
b. Write a C program to copy the contents of one string to another string without using string handling functions.
c. Write a C program to find whether a given string is palindrome or not.

Exercise 11:
Write a C program using recursion for the following:
a. To display sum of digits of a given number
b. To find the factorial of a given integer
c. To find the GCD (Greatest Common Divisor) of two given integers.
d. To find Fibonacci sequence.

Exercise 12:
a. Write a C program to reverse a string using pointers.
b. Write a C program to compare two 2D arrays using pointers.
c. Write a C program consisting of Pointer based function to exchange value of two integers using passing by address.

Exercise 13:

a. Write a C program to find both the largest and smallest number of an array of integers using call by value and call by reference.
b. Write a C program to implement student details using Structures.

Exercise 14:

a. Write a C program which copies one file to another.
b. Write a C program to count the number of characters and number of lines in a file.
c. Write a C program to merge two files into a third file. The names of the files must be entered using command line arguments.

Exercise 15:

Write a C program to implement Different Storage classes.
a. Auto
b. Static
c. Register
d. External

Course Outcomes:

CO1 Examine C syntax, structure and be fluent in the use of C keywords and looping.

CO2 Demonstrate proficiency in handling Strings and File Systems.

CO3 Construct Matrixes creation and operations Programs using Arrays, structures like Dynamic programming.

CO4 Interpret the concepts of Recursion Programming as used in C.

CO5 Construct C programs using Pointers and Functions, various call by reference.

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I Year- II Semester

L	T	P	C
2	0	0	0

PROFESSIONAL ETHICS AND HUMAN VALUES
(MC)

Learning Objectives:

- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values and Loyalty
- To appreciate the rights of others.
- To create awareness on assessment of safety and risk

Unit I: Human Values:

Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others –Living Peacefully –Caring –Sharing –Honesty -Courage-Cooperation–Commitment – Empathy –Self Confidence Character –Spirituality.

Learning outcomes:

1. Learn about morals, values & work ethics.
2. Learn to respect others and develop civic virtue.
3. Develop commitment
4. Learn how to live peacefully

Unit II: Engineering Ethics:

Senses of 'Engineering Ethics-Variety of moral issued –Types of inquiry –Moral dilemmas –Moral autonomy –Kohlberg's theory-Gilligan's theory-Consensus and controversy –Models of professional roles-Theories about right action-Self-interest -Customs and religion –Uses of Ethical theories –Valuing time –Cooperation – Commitment.

Learning outcomes:

1. Learn about the ethical responsibilities of the engineers.
2. Create awareness about the customs and religions.
3. Learn time management
4. Learn about the different professional roles.

Unit III: Engineering as Social Experimentation

Engineering As Social Experimentation –Framing the problem –Determining the facts –Codes of Ethics –Clarifying Concepts –Application issues –Common Ground -General Principles –Utilitarian thinking respect for persons

.**Learning outcomes:**

1. Demonstrate knowledge to become a social experimenter.
2. Provide depth knowledge on framing of the problem and determining the facts.
3. Provide depth knowledge on codes of ethics.
4. Develop utilitarian thinking

UNIT IV: Engineers Responsibility for Safety and Risk:

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Safety and risk –Assessment of safety and risk –Risk benefit analysis and reducing risk-Safety and the Engineer-Designing for the safety-Intellectual Property rights (IPR).

Learning outcomes:

1. Create awareness about safety, risk & risk benefit analysis.
2. Engineer's design practices for providing safety.
3. Provide knowledge on intellectual property rights.

UINIT V: Global Issues

Globalization –Cross-culture issues-Environmental Ethics –Computer Ethics – Computers as the instrument of Unethical behavior –Computers as the object of Unethical acts –Autonomous Computers-Computer codes of Ethics –Weapons Development -Ethics and Research –Analyzing Ethical Problems in research.

Learning outcomes:

1. Develop knowledge about global issues.
2. Create awareness on computer and environmental ethics
3. Analyze ethical problems in research.
4. Give a picture on weapons development.

Course outcomes:

Students will be able to:

- Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field
- Identify the multiple ethical interests at stake in a real-world situation or practice
- Articulate what makes a particular course of action ethically defensible
- Assess their own ethical values and the social context of problems
- Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
- Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work
- Integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research.

Text Books:

1. "Engineering Ethics includes Human Values" by M.Govindarajan, S.Natarajan and, V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009
2. "Engineering Ethics" by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.
3. "Ethics in Engineering" by Mike W. Martin and Roland Schinzinger –Tata McGraw-Hill–2003.
4. "Professional Ethics and Morals" by Prof.A.R.Aryasri, Dharanikota Suyodhana-Maruthi Publications.

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5. "Professional Ethics and Human Values" by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran-LaxmiPublications.
6. "Professional Ethics and Human Values" by Prof.D.R.Kiran-
7. "Indian Culture, Values and Professional Ethics" by PSR Murthy-BS Publication

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I Year- II Semester

L	T	P	C
0	0	2	0

PHYSICAL FITNESS ACTIVITIES
(MC)

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MATHEMATICS – III
(Transforms, PDE and Vector Calculus)
(Common to ALL branches of Second Year B.Tech.)

II Year- I Semester	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

- To familiarize the techniques in partial differential equations
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

Course Outcomes: At the end of the course, the student will be able to

- apply the Laplace transform for solving differential equations (L3)
- find or compute the Fourier series of periodic signals (L3)
- know and be able to apply integral expressions for the forwards and inverse Fourier transform to a range of non-periodic waveforms (L3)
- identify solution methods for partial differential equations that model physical processes (L3)
- interpret the physical meaning of different operators such as gradient, curl and divergence (L5)
- estimate the work done against a field, circulation and flux using vector calculus (L5)

UNIT – I: Laplace Transforms: (10 hrs)

Definition of Laplace transform - Laplace transforms of standard functions – Properties of Laplace Transforms: Shifting theorems –Transforms of derivatives and integrals – Unit step function – Dirac's delta function – Inverse Laplace transforms – Convolution theorem (with out proof).

Applications: Solving ordinary differential equations (initial value problems) and integro differential equations using Laplace transforms.

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UNIT – II: Fourier series and Fourier Transforms: (10 hrs)

Fourier Series: Introduction – Periodic functions – Fourier series of periodic function – Dirichlet's conditions – Even and odd functions – Change of interval – Half-range sine and cosine series.

Fourier Transforms: Fourier integral theorem (without proof) – Fourier sine and cosine integrals – Sine and cosine transforms – Properties (article-22.5 in text book-1) – inverse transforms – Convolution theorem (without proof) – Finite Fourier transforms.

UNIT – III: Partial Differential Equations of first order: **(8 hrs)**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

UNIT – IV: Second order PDE and Applications: (10 hrs)

Second order PDE: Solutions of linear partial differential equations with constant coefficients – Non-homogeneous term of the type $e^{ax+by}, \sin(ax+by), \cos(ax+by), x^m y^n$.

Applications of PDE: Method of separation of Variables – Solution of One dimensional Wave, Heat and two-dimensional Laplace equation.

UNIT – V: Vector calculus: (10 hrs)

Differentiation of vectors – Scalar and vector point functions – Gradient – Directional derivative – Divergence – Curl – Scalar potential.
Integration of vectors – Line integral – Circulation – Work done – Surface integral – Flux – Volume integral – Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof) and their applications.

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.

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2. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. **Dean. G. Duffy,** Advanced Engineering Mathematics with MATLAB, 3rd Edition, CRC Press.
3. **Peter O' Neil,** Advanced Engineering Mathematics, Cengage.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford University Press.

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PETROLEUM GEOLOGY

II Year- I Semester

L	T	P	C
3	0	0	3

Learning Objectives:
The students will be able to:

- Understand the basics of geology, viz: formation of earth, layers of earth and different types of rocks, formation of various types of sedimentary basins for oil and gas accumulation.
- Learn the different geological environments relates to petroleum industry.
- Understand the different sources for hydrocarbons, reservoir and cap-rocks, characterization of reservoir rocks.
- Learn the classification of reservoir pore space, permeability, migration and entrapment, temperature-pressure conditions for the generation of oil and gas from sediments.

UNIT-I:
Origin of the earth and envelops of the earth: Crust, mantle, core- internal dynamics process-plate tectonics- continental drift, external dynamic process-weathering, erosion and deposition. Identification of different structural features encountered in oil exploration viz: joints, faults, folds, unconformities. Origin of igneous, sedimentary and metamorphic rocks. Structures and textures-petrographic character of conglomerate, sandstone, shale, limestone and dolomite.

UNIT-II:
Introduction to sedimentary basins and deltaic systems: Source rocks-Definition of source rocks, organic source rocks, nature and types of source rocks-shale.
The process of diagenesis, catagenesis and metagenesis in the formation of source rocks, Kerogen- types, thermal maturation, sub-surface pressure temperature conditions for the generation of oil and gas from the source sediments – oil window.

UNIT-III:

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Characteristics of Reservoir rocks: Classification and nomenclature- clastic reservoir rocks, carbonate reservoir rocks, unconventional, fractured and miscellaneous reservoir rocks, marine and non-marine reservoir rocks - concept of shale oil.

Reservoir Properties and Cap Rocks: Reservoir pore space, porosity- primary and secondary porosity, effective porosity, fracture porosity – permeability, saturation-effective and relative permeability relationship between porosity, permeability. Cap rocks: definition and characteristics of cap rocks.

UNIT-IV:

Hydrocarbon migration: Geological framework of migration and accumulation, the concept of hydrocarbon migration from source beds to the carrier beds, carrier beds to the reservoir.

Free path ways for migration: Short distance and long distance migration, evidence for migration, oil and gas seepages.

UNIT-V:

Entrapment and accumulation of hydrocarbons: Classification and types of traps, structural, stratigraphic and combination type of traps, traps associated with salt domes.

Sedimentary Basins: Sedimentary basins -origin and classification, types of basins and their relationship to hydrocarbon prospects, tectonic classification, stratigraphic evolution and hydrocarbon accumulations of the following basins: Krishna-Godavari basin, Assam Arakan basin, Cambay basin and Mumbai off-shore.

Outcomes:

After successful completion of the course, the students will be able to:

- Discern the dimension of the earth structure, composition, origin of the earth. It deals essence of scientific studies dealing with the origin, age, structure of the earth and with the evolution, modification, and extinction of various surface and subsurface physical features.
- Apply the concepts of igneous, sedimentary, metamorphic rocks to evaluate drilling operations.
- Identify different source rocks from which hydrocarbons are generated.
- Apply the concepts of formation of source rocks to identify the migration characteristics of hydrocarbons.
- Classify the sources of reservoir rocks, pore space, porosity.

- Gain knowledge of fluid hydrocarbons migration.
- Classify and evaluate the sedimentary basins in India.
- Evaluate and solve technical problems related to the exploration and production of hydrocarbon reservoirs.

Text Book:

1. Geology of Petroleum, A.I. Levorsen, 2nd Edition. CBS, Publishers, 2006.

Reference Books:

1. Elements of Petroleum Geology, Richard, C. Shelley, Elsevier, 1997.
2. Sedimentary basins of India- ONGC bulletin.
3. Unconventional Petroleum Geology, Caineng Zou et al., Elsevier, 2013.

University College of Engineering Kakinada (A)
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FLUID MECHANICS FOR PETROLEUM ENGINEERS

II Year- I Semester	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Learning Objectives:
The students will be able to:

- Understand basic concepts associated with fluid flow such as viscosity, shear, Newtonian and non-Newtonian fluids etc.
- Learn the continuity and Navier Stokes equations as fundamental equations for the analysis of chemical processes.
- Learn the concept of boundary layer theory and governing mathematical equations for Newtonian and non-Newtonian fluid flows.
- Learn the Bernoulli's equation for various simple and complex cases of fluid flow.
- Understand the basic differences between compressible and incompressible fluid flows and suitably adapt, modify and apply correlations for compressible fluid flows.
- Have sound knowledge with respect to various important fluid flows related machinery and equipment including various types of pumps, compressors and blowers.
- Learn the relevant theory for the application of fluid flow past solid surfaces as well as the drag and pressure drop correlations for packed and fluidized beds.
- Understand various accessories required for fluid flow in pipelines.
- Gain the knowledge related to various fluid flow measuring devices.

UNIT-I:
Basic concepts of dimensional analysis, nature of fluids, hydrostatic equilibrium, applications of fluid statics.
Fluid flow phenomena-laminar flow, shear rate, shear stress, rheological properties of fluids.
Difference between flow through pipes and porous media.

UNIT-II:
Basic equation of fluid flow –mass balance in a flowing fluid; continuity, differential momentum balance; equations of motion, macroscopic momentum balances, mechanical energy equations.

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Incompressible Newtonian/non-Newtonian flow in pipes and channels- shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction, losses in pipes.

UNIT-III:
Flow past immersed bodies, drag and drag coefficient, flow through beds of solids, motion of particles through fluids.
Fluidization, conditions for fluidization, minimum fluidization velocity, types of fluidization, expansion of fluidized bed, applications of fluidization, continuous fluidization, slurry and pneumatic transport.

UNIT-IV:
Transportation and metering of fluids- pipes, fittings and valves, pumps: positive displacement and centrifugal pumps.
Measurement of flowing fluids: full bore meters, insertion meters; venturi meter, rotameter, orifice meter, hot wire anemometer, Pitot tube, and other flow metering devices.

UNIT-V:
Flow of compressible fluids- definitions and basic equations, processes of compressible flow, isentropic flow through nozzles, adiabatic frictional flow, and isothermal frictional flow. Compressors, fans, blowers, steam ejectors and jets.
Flow through porous media and application of Darcy's law.

Outcomes:
By mastering the fluid mechanics course, the students shall be able to:

- Analyze fluid flow in circular and non-circular conduits.
- Do the calculations associated with the estimation of friction factor and pressure drop in circular conduits.
- Perform the calculations involving Bernoulli's equation for the transportation of incompressible and compressible fluids.
- Estimate pressure drop in packed and fluidized beds.
- Carry out calculations associated with fluid flow in pumps, compressors, fans and blowers.
- Calculate, analyze and calibrate various flow measuring devices.

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Text Books:

1. Unit Operations of Chemical Engineering, McCabe,W.L., J.C.Smith& Peter Harriot McGraw-Hill, 7th Edition, 2001.
2. Fluid mechanics for Petroleum Engineers, Elemer Bobok, Elsevier,1993.

Reference Books:

1. Introduction to Fluid Mechanics, Fox, R.W. and A. T. McDonald, 5th Edition, John Wiley& Sons, 1998.
2. Transport Processes and Unit Operations, Christie J. Geankoplis, PHI, 2003
3. Chemical Engineering, Vol-1: Fluid flow, Heat Transfer and Mass Transfer, J. M. Coulson and J. F. Richardson, Pergamon Press, 4th Edition, 1990.
4. Fluid Mechanics for Chemical Engineers, Noel De Nevers, Tata McGraw-Hill, 2011.
5. Fluid Flow for Chemical and Process Engineers, Bragg R and F. A. Holland, 2nd Edition, Hodder Stoughton Educational, 1995.
6. Fluid Flow for the Practicing Chemical Engineer, Patrick Abulencia, J and Louis Theodore, John wiley and Sons, 2009.

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HEAT TRANSFER OPERATIONS

II Year- I Semester	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Learning Objectives:
The students will be able to learn:

- The importance of heat transfer in process Industries. Learn different modes of heat transfer and difference between steady and unsteady state heat conduction.
- The importance of LMTD and learn construction and working of different types of heat exchangers.
- The different convective methods and analogy between momentum, heat and mass transfer.
- The phenomena of heat transfer by conduction, convection & radiation.
- The methodology to carry out the detailed process design of shell and tube heat exchangers.

UNIT-I:
Importance of heat transfer in process Industries and Conduction: Nature of heat flow, Modes of heat transfer, Fourier's law, Thermal conductivity and its variation with temperature.
Steady state: heat conduction through plane wall, composite wall, sphere and cylinder, resistance in series.
Unsteady state heat conduction**:** Equation for one-dimensional conduction with constant surface temperature and varying surface temperature; Semi-infinite solid.

UNIT-II:
Principles of heat flow in fluids: Typical heat exchange equipment, counter current and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference. Variable overall coefficient, multi-pass in exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer

UNIT-III:
Heat Transfer to Fluids without Phase change: Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in laminar flow, heat

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transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies. Analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.
Heat transfer to fluids with phase change: Heat transfer from condensing vapors, heat transfer to boiling liquids.

UNIT-IV:
Natural convection: Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar flow heat transfer.
Radiation: Properties and definitions, black body radiation, real surfaces, and the grey body. Absorption of radiation by opaque solids, radiation between surfaces, radiation and shielding, combined heat transfer by conduction, convection and radiation.

UNIT-V:
Heat Exchange Equipment: General design of heat exchange equipment, heat exchangers, condensers, boilers and extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method).
Evaporators: Types of evaporators, performance of tubular evaporator. Capacity and economy, methods of feeding, multiple effect evaporators, vapour recompression.

Outcomes:
The students are able to:
- Apply the basic laws of heat transfer.
- Account for the consequence of heat transfer in thermal analyses of engineering systems.
- Analyze problems involving steady state heat conduction in simple geometries.
- Develop solutions for transient heat conduction in simple geometries.
- Obtain numerical solutions for conduction, convection and radiation heat transfer problems.
- Evaluate heat transfer coefficients for natural convection, forced convection inside ducts and over exterior surfaces.
- Evaluate heat transfer coefficients for forced convection and analyze heat exchanger performance by using the method of log mean temperature difference.
- Apply the principles of convection to design various heat transfer equipment.
- Analyze heat exchanger performance by using the method of heat exchanger effectiveness.

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- Calculate radiation heat transfer between black body surfaces as well as grey body surfaces.

Text Books:

1. Unit Operations of Chemical Engineering, McCabe, W.L., J.C Smith and Peter Harriott, 7th Edition, McGraw-Hill, 2005.
2. Process Heat Transfer, D.Q. Kern, Tata- McGraw-Hill, 1997.
3. Heat Transfer, Holman, J.P., 9th Edition, Tata McGraw-Hill, 2008.

Reference Books:

1. Heat Transfer, Y.V.C. Rao, Universities Press (India) Pvt. Ltd., 2001.
2. Schaum's Outline of Heat Transfer, Donald Pitts and L. E. Sisson, 2nd Edition, McGraw-Hill, 1998.
3. A Text Book on Heat Transfer, Sukhatme, P., 5th Edition, Universities Press (India) Pvt. Ltd., 2005.
4. Heat Transfer: Principles and Applications, Binay Dutta, K., PHI Learning, 2009.
5. Chemical Engineering: Fluid Flow, Heat Transfer and Mass Transfer, Coulson, J.M.; Richardson, J.F.; Backhurst, J.R.; Harker, J.H., Vol.1, 6th Edition, Reed Elsevier India, 2006.

University College of Engineering Kakinada (A)
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MATERIAL AND ENERGY BALANCES

II Year- I Semester	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Learning Objectives:
The students will be able to:

- Understand and correctly implement unit conversions in process calculations.
- Understand and apply theoretical knowledge towards problem solving in chemical processes.
- Analyze and solve elementary material balances in physical and chemical processes.
- Analyze and solve elementary energy balances in reactive and non-reactive processes.
- Formulate and solve combined material and energy balances for combustion of fuels.
- Realize the relevance of thermodynamics in process calculations.
- Carry out complex process calculations using MS Excel/MATLAB.

UNIT-I:
Stoichiometric relations: Basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales, units and inter conversions.
Behaviour of Ideal gases: Kinetic theory of gases, application of ideal gas law, gaseous mixtures, gases in chemical reactions.

UNIT-II:
Material balances: Tie components, yield and material balance with and without reaction, conversion. Material balance calculations in simple drying, dissolution and crystallization processes. Processes involving chemical reactions. Processes involving recycles, bypass, purge and other complexities.

UNIT-III:
Energy Balances: Energy, energy balances, heat capacity of gases, liquid and mixture solutions. Kopp's rule, Latent heats, heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for nonpolar liquids enthalpy and its evaluation.
Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchoff's equation, enthalpy concentration change, calculation of theoretical and actual flame temperatures.

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UNIT-IV:

Vapour pressure and VLE: Liquefaction and liquid state, vaporization, boiling point, Effect of temperature on vapour pressure, Antoine equation, vapour pressure plots (ternary),estimation of critical properties, vapour pressure of immiscible liquids and ideal solutions, Raoult's law, non-volatile solutes.

Humidity and Saturation: Relative and percentage saturation or dew point, wet bulb and dry bulb temperature, use of humidity charts for engineering calculations

UNIT-V:

Combustion Calculations: Introduction to fuels, calorific value of fuels, coal, liquid fuels, Gaseous fuels, air requirement and flue gases, combustion calculations, incomplete combustion, material and energy balances, thermal efficiency calculations.

Outcomes:

The students are able to:

- Apply all basic and background information/charts/datasheets required to carry out process calculations. Some of these are vapour pressure correlations, latent heat correlation, steam tables, psychrometric charts, enthalpy-concentration diagrams etc.,
- Formulate and solve simple and moderately complex process calculations associated to industrially prominent chemical processes and technologies.
- Formulate and solve material and energy balances in physical and reactive systems including fuel combustion.
- Conceptualize an integrated methodology that encompasses the knowledge in other subjects (Physical Chemistry, Thermodynamics and Mathematics) and MS Excel/MATLAB for a systematic and structured approach towards chemical process calculations.
- Analyze chemical processes through the power of modelling and computation. These include back-calculation methods, inventory losses and revenue related assessment etc.

Text Books:

1. Chemical Process Principles, Part-I, Material and Energy Balances, Hougen O A, Watson K. M. and Ragatz R.A., 2nd Edition, CBS Publishers & distributors, New Delhi, 2010.
2. Basic Principles and Calculations in Chemical Engineering, D.H. Himmelblau, 7th Edition. PHI, New Delhi, 2009.

Reference Books:

1. Elementary Principles of Chemical Processes, R. M. Felder and R. W. Rousseau, 3rd Ed., Wiley, 1999.
2. Handbook Chemical Engineering Calculations, N. Chopey, 3rd Edition, Mc-Graw Hill, 2004.
3. Stoichiometry, Bhatt, B. I., Thakore S. B., 5th Ed., Tata Mc-Graw Hill Education 2010.
4. Stoichiometry and Process Calculations, K. V. Narayanana and B. Lakshmikutty, PHI Learning Private Ltd., 2017
5. Principles of Chemical Engineering Processes: Material and Energy Balances, Nayef Ghasem and R. Henda, 2nd Edition, CRC Press, 2

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PETROLEUM GEOLOGY – LABORATORY

II Year- I Semester	**L**	**T**	**P**	**C**
	0	**0**	**3**	**1.5**

Learning Objectives:
The students will be able to:

- Distinguish between sandstone and carbonate reservoir rocks.
- Differentiate source rocks and the reservoir rocks.
- Identify location of outcrop on the topo-sheet.
- Learn the locational geological mapping and traversing.
- Measure strike and dip.
- Learn the importance of litho-stratigraphic columns and plotting geological cross sections.
- Determine the location of oil-water contact in the reservoir.

List of Experiments:

1. Identifying the distinction between sandstone and carbonate reservoir rocks.
2. Location of observed outcrop on the Topo-sheet. Locational Geological mapping and traversing.
3. Measurement of the strike, dip along for the calculation of apparent and true thickness of outcrops.
4. Preparation of correlations for litho stratigraphic columns and estimation of geological cross section.
5. Preparation of structural contour map and location of Oil Water Contact (OWC)
6. Identification of various hydrocarbon traps.
7. Mapping of contour lines/ Isolines for different geological structures.
8. Correlation of SP and ɣ- ray data for well lithology.
9. Mapping of the migration petroleum system.
10. Identifying source rock parameters

Outcomes:
The students will be able to:

- Assess the differences between sandstone and carbonate reservoir rocks.
- Identify the various hydrocarbon traps.

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- Plot the litho stratigraphic column graphically and estimate the geological cross-section.
- Correlate the SP and Gamma ray data for well mapping.
- Plot contour lines for interpretation of a geological structure.
- Calculate the source rock parameters.
- Map the migration petroleum systems.
- Confirm the height of the oil-bearing sand.
- Use the maps to estimate reservoir area and thickness.

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FLUID MECHANICS FOR PETROLEUM ENGINEERS – LABORATORY

II Year- I Semester	**L**	**T**	**P**	**C**
	0	**0**	**3**	**1.5**

Learning Objectives:
The students will be able to learn:

- The determination of discharge coefficient of orifice, venturi, notches.
- The determination of friction factors in pipes, pressure drop in packed and fluidized beds, fluid viscosity.
- The characteristics of centrifugal pump and reciprocating pump.
- The characterization of fluid flow, verification of Bernoulli's theorem, and measurement of point velocities.

List of Experiments:

1. Identification of laminar and turbulent flows; Major equipment - Reynolds apparatus
2. Measurement of point velocities; Major equipment - Pitot tube setup
3. Verification of Bernoulli's equation; Major equipment – Bernoulli's Apparatus
4. Calibration of Rotameter; Major equipment – Rotameter Assembly
5. Variation of Orifice coefficient with Reynolds Number; Major equipment - Orifice meter Assembly.
6. Determination of Venturi coefficient; Major equipment – Venturi meter Assembly
7. Friction losses in Fluid flow in pipes; Major equipment - Pipe Assembly with provision for Pressure measurement
8. Pressure drop in a packed bed for different fluid velocities; Major equipment - Packed bed with Pressure drop measurement
9. Pressure drop and void fraction in a fluidized bed; Major equipment - Fluidized bed with Pressure drop measurement
10. Studying the coefficient of contraction for a given open orifice; Major equipment - Open Orifice Assembly
11. Studying the coefficient of discharge in a V-notch; Major equipment - V-notch Assembly
12. Studying the Characteristics of a centrifugal pump; Major equipment - Centrifugal Pump

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13. Viscosity determination using Stoke's law; Major equipment – Terminal Velocity determination column.

Outcomes:

The students are able to:

- Determine the discharge coefficients of orifice and venturi metres as well as notches.
- Measure the point velocity using pitot tube.
- Measure the velocities and flowrates using various devices.
- Estimate the skin and form frictional losses in pipes and fittings.
- Verify the Bernoulli's and Ergun equations in packed and fluidized beds.
- Verify Newton's law of viscosity.
- Estimate the mechanical efficiency of centrifugal pump.
- Determine terminal velocity using Stoke's law.

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HEAT TRANSFER OPERATIONS – LABORATORY

II Year- I Semester	**L**	**T**	**P**	**C**
	0	**0**	**3**	**1.5**

Learning Objectives:
The students will be able to learn:

- The determination of thermal conductivities of composite wall and metal rod.
- Estimation of the natural and forced convective heat transfer coefficients (both film and overall coefficients).
- The determination of critical heat flux for pool boiling of water.
- The estimation of temperature distribution along the length of a pin-fin under natural and forced convection conditions
- The determination of Stefan-Boltzmann constant, emissivity of a metal plate etc.

List of Experiments:

1. Determination of total thermal resistance and thermal conductivity of composite wall.
2. Determination of thermal conductivity of a metal rod.
3. Determination of natural convective heat transfer coefficient for a vertical rod.
4. Determination of critical heat flux for pool boiling of water.
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe.
6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
7. Study of the temperature distribution along the length of a pin-fin under natural and forced convection conditions.
8. Estimation of un-steady state film heat transfer coefficient between the medium in which the body is cooled.
9. Determination of Stefan – Boltzmann constant.
10. Determination of emissivity of a given plate at various temperatures.

Outcomes:
The students are able to:

- Experimentally determine of thermal conductivities of composite wall and metal rod.

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- Calculate the natural and forced convective heat transfer coefficients (both film and overall coefficients) from experimental data.
- Estimate the experimental critical heat flux from pool boiling of water.
- Determine the temperature distribution along the length of a pin-fin under natural and forced convection conditions
- Determine the Stefan-Boltzmann constant, emissivity of a metal plate etc.

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PYTHON PROGRAMMING
(SC)

II Year- I Semester

L	T	P	C
1	0	2	2

OBJECTIVES:

- Introduction to Scripting Language
- Exposure to various problems solving approaches of computer science

Course Outcomes: At the end of the course, student will be able to

CO	Course Outcome	Knowledge Level (K)#
CO1	**Understand** and comprehend the basics of python programming. Demonstrate the principles of structured programming and be able to describe, design, implement, and test structured programs using currently accepted methodology	K2
CO2	**Demonstrate** the principles of structured programming and be able to describe, design, implement, and test structured programs using currently accepted methodology. Explain the use of the built-in data structures list, sets, tuples and dictionary	K3
CO3	**Understand** of functions and its applications, Modules.	K3
CO4	**Identify** real-world applications using oops, files and exception handling provided by python.	K3
CO5	**Formulate** and implement a program to solve a real-world problem using GUI and Turtle graphics.	K3

- *#Based on suggested Revised BTL*
- **Mapping of course outcomes with program outcomes**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M				M			M			H
CO2	H				H		M				H	
CO3	M	M			H				H			
CO4	M			M			H				M	H
CO5		L		H			M				L	

- **(Please fill the above with Levels of Correlation, viz., L, M, H)**

UNIT – I:

Introduction: History of Python, Need of Python Programming, Applications Basics of Python Programming Using the REPL(Shell), Running Python Scripts, Variables, Assignment, Keywords, Input-Output, Indentation.

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ENVIRONMENTAL SCIENCE
(MC)

II Year- I Semester	**L**	**T**	**P**	**C**
	2	**0**	**0**	**0**

Learning Objectives: The objectives of the course are to impart:

- Overall understanding of the natural resources.
- Basic understanding of the ecosystem and its diversity.
- Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities.
- An understanding of the environmental impact of developmental activities.
- Awareness on the social issues, environmental legislation and global treaties.

UNIT-I:

Multidisciplinary nature of Environmental Studies: Definition, Scope and Importance – Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects. Role of information technology in environment and human health.

Ecosystems: Concept of an ecosystem. - Structure and function of an ecosystem; Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

UNIT-II:

Natural Resources: Natural resources and associated problems.

Forest resources: Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest and tribal people.

Water resources: Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

Food resources: World food problems, changes caused by non-agriculture activities- effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.

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Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

UNIT-III:

Biodiversity and its conservation: Definition: genetic, species and ecosystem diversity- classification - Value of biodiversity: consumptive use, productive use, social- Biodiversity at national and local levels. India as a mega-diversity nation - Hot-sports of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

UNIT – IV:

Environmental Pollution: Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and his well being.

Solid Waste Management: Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.

UNIT – V:

Social Issues and the Environment: Urban problems related to energy -Water conservation, rain water harvesting - Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act -Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act -Wildlife Protection Act -Forest Conservation Act-Issues involved in enforcement of environmental legislation.
-Public awareness.

Environmental Management: Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism, Green Campus – Green business and Green politics.

The student should Visit an Industry / Ecosystem and submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

Text Books:

1. Environmental Studies, K. V. S. G. Murali Krishna, VGS Publishers, Vijayawada
2. Environmental Studies, R. Rajagopalan, 2nd Edition, 2011, Oxford University Press.
3. Environmental Studies, P.N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani;Pearson Education, Chennai

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Reference:

1. Text Book of Environmental Studies, Deeshita Dave & P. UdayaBhaskar, CengageLearning.
2. A Textbook of Environmental Studies, Shaashi Chawla, TMH, New Delhi
3. Environmental Studies, Benny Joseph, Tata McGraw Hill Co, New Delhi
   Perspectives in Environment Studies, Anubha Kaushik, C P Kaushik InternationalPublishers, 2014.

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Management and organizational Behavior

II Year-II Semester

L	T	P	C
3	0	0	3

Course Objectives:

- To familiarize with the process of management and to provide basic insight into select contemporary management practices
- To provide conceptual knowledge on functional management Human resource management, strategic management and Organisational Behavior.

Unit I

Introduction: Management and organizational concepts of management and organization- Nature and Importance of Management, Functions of Management, System approach to Management - Taylor's Scientific Management Theory, Fayol's Principles of Management, Leadership Styles, Social responsibilities of Management. Designing Organizational Structures: Basic concepts related to Organization - Departmentation and Decentralization, MBO, Process and concepts.

Unit II

Functional Management: Human Resource Management (HRM) Concepts of HRM, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Wage and Salary Administration Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating. - Marketing Management: Concepts of Marketing, Marketing mix elements and marketing strategies.

Unit III

Strategic Management: Strategic Management and Contemporary Strategic Issues: Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and implementation, Generic Strategy alternatives. Bench Marking and Balanced Score Card as Contemporary Business Strategies.

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Unit IV

Individual Behavior: Perception-Perceptual process- Impression management- Personality development – Socialization – Attitude- Process- Formation- Positive attitude- Change – Learning – Learning organizations- Reinforcement Motivation – Process- Motives – Theories of Motivation: Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation,

Unit V

Group Dynamics: Types of Groups, Stages of Group Development, Group Behaviour and Group Performance Factors, Organizational conflicts: Reasons for Conflicts, Consequences of Conflicts in Organization, Types of Conflicts, Strategies for Managing Conflicts, Organizational Climate and Culture, Stress, Causes and effects, coping strategies of stress.

Reference Books:

1. Subba Rao P., *Organizational Behaviour,* Himalaya Publishing House. Mumbai.
2. Fred Luthans *Organizational Behaviour*, TMH, New Delhi.
3. Robins, Stephen P., *Fundamentals of Management,* Pearson, India.
4. Kotler Philip & Keller Kevin Lane: Marketing Mangement12/e, PHI, 2007
5. Koontz & Weihrich: *Essentials of Management*, 6/e, TMH, 2007
6. Kanishka Bedi, *Production and Operations Management*, Oxford University Press, 2007.

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MATHEMATICS-IV

II Year-II Semester	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

- To familiarize the complex variables.
- To familiarize the students with the foundations of probability and statistical methods.
- To equip the students to solve application problems in their disciplines.

UNIT – I: Functions of a complex variable and Complex integration: (10 hrs)

Introduction – Continuity – Differentiability – Analyticity – Cauchy-Riemann equations in Cartesian and polar coordinates – Harmonic and conjugate harmonic functions – Milne – Thompson method.

Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula – Generalized integral formula (all without proofs) and problems on above theorems.

UNIT – II: Series expansions and Residue Theorem: (10 hrs)

Radius of convergence – Expansion in Taylor's series, Maclaurin's series and Laurent series.

Types of Singularities: Isolated – Essential – Pole of order m – Residues – Residue theorem (without proof) – Evaluation of real integral of the types $\int_{-\infty}^{\infty} f(x)dx$ and $\int_{c}^{c+2\pi} f(\cos\theta, \sin\theta)d\theta$.

UNIT – III: Probability and Distributions: (10 hrs)

Review of probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution functions – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

UNIT – IV: Sampling Theory: (8 hrs)

Introduction – Population and Samples – Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Representation of the normal theory distributions – Introduction to t, χ^2 and F-distributions – Point and Interval estimations – Maximum error of estimate.

UNIT – V: Tests of Hypothesis: (10 hrs)

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Test of significance for large samples: Single and two means – Single and two proportions – Student's t-

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distribution: Significance test of a sample mean – Significance test of difference between sample means.

Course Outcomes: At the end of the course students will be able to

- apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic (L3)
- find the differentiation and integration of complex functions used in engineering problems (L5)
- make use of the Cauchy residue theorem to evaluate certain integrals (L3)
- apply discrete and continuous probability distributions (L3)
- design the components of a classical hypothesis test (L6)
- infer the statistical inferential methods based on small and large sampling tests (L4)

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. Miller and Freund's, Probability and Statistics for Engineers, 7/e, Pearson, 2008.

Reference Books:

1. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 9th edition, Mc-Graw Hill, 2013.
2. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.
3. Jay l. Devore, Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage.
4. Shron L. Myers, Keying Ye, Ronald E Walpole, Probability and Statistics Engineers and the Scientists, 8th Edition, Pearson 2007.Sheldon, M. Ross, Introduction to probability and statistics Engineers and the Scientists, 4th Edition, Academic Foundation, 2011

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INSTRUMENTATION, PROCESS DYNAMICS & CONTROL

II Year-II Semester	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Learning objectives:
The student will be able to learn:

- The basic elements of an instrument and its static and dynamic characteristics.
- The various types of industrial thermometers.
- The various types of instruments for measurement of pressure, vacuum, head and density measurement.
- The behavior and logic of different types of advanced controllers and their strategies.
- The how Laplace transforms can be used to get solutions of transfer function equations for different types of systems.
- The basic procedure to derive transfer functions for first order, pseudo second order and second order systems.
- The importance of under damped second order systems in relation to the real life situations.
- The calculation of the overall transfer function and thus offset calculation from the control system block diagram.
- The concept of stability, stability criterion and frequency response analysis for sinusoidal forcing functions.
- The behavior and tuning of a controller and the calculation of controller parameters.
- The inherent and effective characteristics of different types of control valves and the usage of valve positioners to induce linear characteristic into a non-linear control valve.

UNIT-I:
Fundamentals: Elements of instruments, static and dynamic characteristics of instruments.
Industrial Thermometers**:** Mercury in glass thermometer - Bimetallic thermometer - Pressure spring thermometer, Thermo-electricity – types of thermocouples – Thermocouple lead wires. Resistance-thermometers: RTD and bridge circuits (2 wire, 3 wire and 4 wire - method) -Radiation receiving elements- pyrometers.

UNIT-II:

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Pressure, vacuum and head: Liquid column manometers - Measuring elements for gauge pressure and vacuum-indicating elements for pressure gauges - Measurement of absolute pressure - Measuring pressure in corrosive liquids - Static accuracy and response of pressure gauges.
Density and specific gravity measurements- Direct measurement of liquid level - Pressure measurement in open vessels - Level measurements in pressure vessels - Measurement of interface level - Density measurement and level of dry materials.

UNIT-III:
Introduction to process dynamics and control, Response of First Order Systems, Physical examples of first order systems.
Response of first order systems in series, higher order systems: Second order and transportation lag. Control systems Controllers and final control elements.

UNIT-IV:
Closed loop transfer functions, Transient response of simple control systems.
Stability: Stability Criterion, Routh Test, Root locus, Introduction to frequency response, Bode stability criterion, concept on gain and phase margins

UNIT-V:
Advanced control strategies: Cascade control, Feed forward control, ratio control, dead time compensation, internal model control.
Controller tuning and process identification. Control valves.

Outcomes:
The students are able to:

- Analyze the basic elements of an instrument and its characteristics.
- Measure the various process variables using the appropriate types of instruments process variables (temperature, pressure, flow rate, composition, pH, viscosity, density, dry bulb and wet bulb temperatures).
- Apply the partial fractions and Laplace transforms for converting ordinary differential equations into simple algebraic equations which are easier to solve.
- Write the different types of unsteady and steady state balances.
- Describe processes with appropriate block diagrams.
- Model a process numerically.
- Identify the stability limits of a system.
- Apply the advance control strategies.
- Tune the process controllers.

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- Experimentally determine the dynamic behavior of a process.
- Design and operate control valves.

Text Book:

1. Industrial Instrumentation, Donald P. Eckman, CBS, 2004.
2. Process Systems Analysis and Control, D.R. Coughanowr, 3rd Ed. McGraw Hill

Reference Books:

1. Chemical Process Control, G. Stephanopoulos, Prentice Hall, 1984.
2. Coulson and Richardson's Chemical Engineering, Volume-3, 3rdEdition: Chemical and Biochemical Reactors and Process Control, Richardson J. F. et.al, Elsevier India, 2006.
3. Automatic Process Control, Donald P. Eckman, John wiley, Reprint 2011.
4. Instrumentation and Control Systems, K. Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016.
5. Process Dynamics and Control, Dale Seaborg, Thomas F. Edgar, Duncan Mellichamp, 2ndEdition, Wiley India Pvt. Ltd., 2006.
6. Principles of Process Control. Patranabis, 3rdEdition McGraw-Hill Education Pvt. Ltd., 2012.
7. Modern Control Engineering, Katsuhiko Ogata, 5th Edition, Prentice Hall, 2010.
8. Principles and Practices of Automatic Process Control, Carlos A. Smith, Armando B. Corripio, 3rd International Edition, John Wiley and Sons, 2005.

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THERMODYNAMICS FOR PETROLEUM ENGINEERS

II Year-II Semester	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Learning Objectives:

The students will be able to learn:

- The laws of thermodynamics and their application to petroleum engineering systems.
- The volumetric properties, thermodynamic property relations and equations of states for pure substances.
- The concepts of chemical potentials, Gibbs and Helmholtz free energies.
- The phase behavior and properties of pure fluids with applications to the analysis of petroleum systems.
- The concept of residual and excess property relations.
- The concepts of fugacity and partial molar properties.
- VLE calculations using Raoult's law, modified Raoult's law, Henry's law activity coefficient models, generalized gamma/phi formulation and
- K-values.
- VLE calculations from equation of state.
- The concepts of Vapor Liquid–Liquid Equilibrium (VLLE), Solid- Liquid Equilibrium (SLE), Solid-Vapor Equilibrium (SVE) and equilibrium adsorption of gases on solids.

UNIT-I:

Introduction: The scope of thermodynamics, defined quantities; temperature, volume, pressure, work, energy, heat, Joules experiments, SI units.

The first law and other basic concepts: The first law of thermodynamics, thermodynamic state and state functions, enthalpy, The steady-state steady flow process, equilibrium, the reversible process, constant-V and constant- P processes, heat capacity.

UNIT-II:

Volumetric properties of pure fluids: The PVT behavior of pure substances, virial equations, the ideal gas, the applications of the virial equations, cubic equations of state, generalized correlations for gases.

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UNIT-III:

The second law of thermodynamics: Statements of the second law, heat engines, thermodynamic temperature scales, thermodynamic temperature and the ideal-gas scale,
entropy, entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, calculation of ideal work and lost work, examples on thermodynamic behavior of oil and natural gas under reservoir conditions.

UNIT-IV:

Thermodynamic properties of fluids: Property relations for homogeneous phases, residual properties, two phase systems, thermodynamic diagrams, tables of thermodynamic properties, generalized property correlations for gases.

Thermodynamics of flow processes: Principles of conservation of mass and energy for flow systems, analysis of expansion processes; turbines, throttling, compression processes, compressors and pumps.

UNIT-V:

Solution thermodynamics: Basic concepts of chemical potential, phase equilibria, partial properties, fugacity coefficient, residual and excess Gibbs free energy, correlations for the estimation of fugacity coefficient, residual and excess Gibbs energy in vapor liquid equilibria.

Phase Equilibria: Gamma/Phi formulation of VLE, VLE from Virial Equations of State and cubic equations of state, introduction to Vapor- Liquid–Liquid Equilibrium (VLLE), Solid- Liquid Equilibrium (SLE) and Solid-Vapor Equilibrium (SVE), Equilibrium adsorption of gases on solids.

Outcomes:

The students are able to:

- Apply the laws of thermodynamics and their application to petroleum engineering systems.
- Apply the volumetric properties, thermodynamic property relations and equations of states to the pure substances.
- Analyze the concepts of chemical potentials, Gibbs and Helmholtz free energies.
- Assess the requirement of properties of pure fluids and their mixtures to the analysis of petroleum systems.

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- Apply the concepts of fugacity, fugacity coefficients in the calculation of phase equilibrium.
- Perform VLE calculations using Raoult's law, modified Raoult's law, Henry's law activity coefficient models, generalized gamma/phi formulation and K-values.
- Carry out VLE calculations from equation of state.
- Apply the concepts of Vapor Liquid–Liquid Equilibrium (VLLE), Solid- Liquid Equilibrium (SLE), Solid-Vapor Equilibrium (SVE) and equilibrium adsorption of gases on solids to petroleum systems.

Text Book:

1. Introduction to Chemical Engineering Thermodynamics, Smith, J. M., H. C. Van Ness and M.M. Abbott, 6th Edition, 8th reprint, McGraw Hill, 2006.

Reference Books:

1. Characterization and Properties of Petroleum Fractions, M. R. Riaze, ASTM, International, 2005.
2. Equation of State and PVT analysis, Tarek Ahmed, Gulf publishing company, 2007.
3. Engineering and Chemical Thermodynamics, Koretsky, M. D., John Wiley & Sons, 2004.
4. Introductory Chemical Engineering Thermodynamics, Richard Elliott, J. and Carl T. Lira, 2nd Edition, Prentice Hall, 2012.
5. Chemical, Biochemical and Engineering Thermodynamics, Stanley Sandler, 4th Edition, Wiley India Pvt. Ltd, 2006.
6. Thermodynamics: Applications in Chemical Engineering and the Petroleum Industry, Vidal, J., Edition Technip, 2003.
7. Chemical and Process Thermodynamics, Kyle, B.G., 3rd Edition, PHI Learning, 2008.
8. Chemical Engineering Thermodynamics, Thomas E. Dauber, McGraw Hill, 1985.

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DRILLING & WELL COMPLETIONS

II Year-II Semester	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Learning Objectives:
The students will be able to:

- Understand the planning of drilling a well, the process of drilling and various equipment used for drilling and design of the drill string.
- Know the drilling fluid importance and its properties and hydraulics.
- Understand different types of casings lowered in a well, the requirement of cementation in a well and cement slurry design.
- Learn the different tools used for directional drilling and various techniques, fishing, stuck pipe and well control concepts.
- Understand the fundamentals of well testing.
- Gain the knowledge of surface and subsurface equipment.
- Understand the planning and designing of well completion after testing of the hydrocarbon zones available.
- Gain the knowledge of subsurface circulating equipment and packers. Testing of multi zones in a well with DST/RFT with logging tools as well as surface testing equipment.

UNIT-I:
Overview of drilling: Drilling plan - GTO -types of drilling, hydrostatic pressure, pore pressure, causes of abnormal pore pressure, abnormal pore pressure evaluation - measurement while drilling & logging while drilling data -direct measurements of pore pressure – drilling fluid properties - drilling fluid hydraulics calculations - bit hydraulics formation integrity tests – fracture gradient determination – theory of Wellbore – FIT procedural guidelines – predicting fracture gradient.

UNIT-II:
Wellbore stability – In-situ stress - determination of rock properties, failure criteria – stress distribution around a wellbore - safe mud weights to prevent hole collapse, kick tolerance use of kick tolerance to calculate wellbore pressures.
Casing: Functions of casing – types of casing – casing properties and specifications – casing connections – factors influencing casing design – combination strings – tension criterion - compression loads – biaxial effects – tri axial analysis.
Cementation: Introduction to cement slurries - cementing nomenclature - cement additives.

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UNIT III:

(a) Directional drilling: Well planning - deflection tools and techniques - face orientation - direction control with rotary assemblies - navigation drilling systems; horizontal wells – well profile design considerations – torque and drag –extended reach well design – multilateral wells.
Kicks – BOP - special kick problems and procedures to free the pipes and fishing operations

b) Well completion: Types of wells- types of completion. Perforation methods. Packers: Function – Application.

UNIT – IV:

Completion equipment (SSD, SSSV, mandrels, locks etc.) –Subsea well completions, permanent gauges - memory gauges - intelligent completion equipment. Tubing string design.

UNIT – V:

Drill Stem Testing: General Procedure and considerations - test tool components and arrangement - analysis of test data. HPHT and horizontal well completions, work over operations, CTU & slick line operations.

Outcomes:

The students are able to:

- Learn the principles of drilling and operation of various equipment used for drilling.
- Assess the application of drilling fluids depending upon the formations.
- Understand the different types of casings and the concepts of cementation.
- Learn the usage of different tools for directional drilling, fishing, stuck pipe and well control.
- Understand the fundamentals of well completions.
- Testing the multi zones in a well with DST/RFT with logging tools as well as surface testing equipment.

Text Books:

1. Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc., 1960.
2. Working Guide to Drilling Equipment and Operations, William Lyons, Gulf Publishing, 2009.
3 Well Completion and Servicing, D. Perrin, Micheal Caron, Georges Gaillot, Editions Technip, 1999.

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4 Primer of Well Service, Workover and Completion, Petroleum Extension Service (PETEX), University of Texas at Austin, 1997.

Reference Books:

1. Drilling Engineering, J.J. Azar and G. Robello Samuel, Pennwell Books, 2007.
2. Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman, 1985.
3. Drilling Engineering: A Complete Well Planning Approach, Neal Adams, Tommie CharrierPennwell, 1985.
4. Practical Well Planning and Drilling Manual, Steve Devereux, Pennwell, 1998.
5. Formulas and Calculation for Drilling, Production and Workover, Norton J. Lapeyrouse, 2nd Edition, Gulf Publishing, 2002.
6. Applied Drilling Engineering, Adam T. Bourgoyne Jr., Keith K. Millheim, Martine E. Chenevert and F. S. Young Jr., Society of Petroleum Engineers, 1991.
7. Well Engineering and Construction, HussainRabia, Entrac Consulting, 2002.
8. Fundamentals of Drilling Engineering, Robert F. Mitchell, Stefan Z. Miska, Society of Petroleum Engineers, 2011.
9 Well Completion Design, Jonathan Bellarby, Elsevier, 2009.
10. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman, Inc., 1986.
11. Advanced Well Completion Engineering, Wan Renpu, Gulf Professional Publishing, 2011.
12 Well Testing, John Lee, Society of Petroleum Engineers, 1982.

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B. Tech. Chemical Engineering Syllabus, R20 – Regulation
INSTRUMENTATION, PROCESS DYNAMICS & CONTROL – LABORATORY

II Year-II Semester	**L**	**T**	**P**	**C**
	0	**0**	**3**	**1.5**

Learning Objectives:

The students will be able to learn:

- Calibration and determination of the time lag of various first and second order instruments.
- The determination of the response in single and two capacity systems with and with-out interaction.
- The advanced control methods used for complex processes in the industries. Different experiments like Temperature, level and pressure control can be configured and studied.
- The experimental procedures for open loop (Manual control) and the on/off controller, Proportional controller, PI controller, PD controller, PID controller, Tuning of controller (Open loop and close loop methods).
- The control valve operation and its flow characteristics.
- The determination of the damping coefficient and response of U-tube manometer.

Experiments:

1. Determination of time constant & transportation lag for mercury in glass thermometer with and without thermal well.
2. Sinusoidal response of mercury in glass thermometer with and without thermal well.
3. Study of dynamic response of single tank liquid level system.
4. Study of dynamic response of two tank non-interacting liquid level system.
5. Study of dynamic response of two tank interacting liquid level system.
6. Determination of damping coefficient for U-tube:
7. Study of control valve characteristics and determine valve flow coefficient for the following valves:
   a) Equal percentage valve
   b) Quick opening valve
   c) Linear valve
8. Determination of hysteresis for the following valves:
   a) Equal percentage valve
   b) Quick opening valve
   c) Linear valve

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9. Temperature control trainer:
    a) Open loop response
    b) On-off control
    c) P-control
    d) PID-control
    e) Auto tuning
10. Level control trainer:
    a) Open loop response
    b) On-off control
    c) P-control
    d) PID-control
    e) Auto tuning
11. Pressure control trainer:
    a) Open loop response
    b) On-off control
    c) P-control
    d) PID-control
    e) Auto tuning

Outcomes:

The students will be able to:

- Calibrate and determine the time lag of various first and second order instruments.
- Perform experiments to find the response in single and two capacity systems with and with-out interaction.
- Apply the advanced control methods used for complex processes in the industries.
- Perform different experiments like Temperature, level and pressure control.
- Carry out experiments on the open loop (Manual control) and the on/off controller, Proportional controller, PI controller, PD controller, PID controller, Tuning of controller (Open loop and close loop methods).
- Operate the control valve and assess its flow characteristics.
- Estimate the damping coefficient and response of U-tube manometer.

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MATHEMATICAL METHODS FOR PETROLEUM ENGINEERS – LABORATORY

II Year-II Semester	**L**	**T**	**P**	**C**
	0	**0**	**3**	**1.5**

Learning Objectives:
The students will be able to learn:

- The application of MATLAB to solve various rigorous and iterative problems related to various petroleum engineering topics.
- The what-if analysis for the variations in the parameters using mathematical methods.

List of problems:

1. Solution of simultaneous equations for steady state material balance on a separation train.
2. Linear regressions after proper transformation to a linear expression for vapor-pressure correlation by Clapeyron Equation.
3. Fitting polynomials & correlations using vapor pressure data.
4. Solution of single non-linear algebraic equation for bubble point calculation of an ideal binary mixture.
5. Least square method of analysis to obtain the relation between friction factor and Reynolds number.
6. Graphical integration for calculation of average velocity for flow of water.
7. Determination of molar volume and compressibility from Redlich – Kwong equation of state.
8. Calculation of flow rate in a pipeline.
9. Calculation of compressibility factors using van der Waals equation of state.
10. Thermodynamic properties of steam from Redlich – Kwong equation of state.
11. Method of lines for partial differential equations to obtain temperatures along the slab.
12. Correlation of experimental data on heat capacity, viscosity and thermal conductivity to polynomials.

Outcome:

- The students are able to write MATLAB code and solve typical problems encountered in petroleum engineering.

Textbook:

1. Problem solving in Chemical and Biochemical Engineering with POLYMATH, Excel and MATLAB, Michael B. Cutlip and Mordechai Shacham, 2nd edition, Prentice Hall, 2008.

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DRILLING FLUIDS – LABORATORY

II Year-II Semester	**L**	**T**	**P**	**C**
	0	**0**	**3**	**1.5**

Learning Objective:

The students will be able to learn:

- The determination of the properties of different drilling fluids.

List of Experiments:

1. Measurement of drilling fluid weight.
   Equipment: The Baroid mud balance
2. Measurement of mud viscosity.
   Equipment: Marsh funnel
3. Measurement of pH of mud.
   Equipment: pH meter and hydrion pH dispensers
4. Determination of mud rheology (Viscosity, Gel strength, and Yield point).
   Equipment: The Baroidrheometer
5. Determination of the loss of liquid from a mud.
   Equipment: Standard API filter press
6. Measurement of a drilling mud cake and evaluate resistivity.
   Equipment: Baroid digital resistivity meter
7. Measurement of the effect of adding bentonite on mud properties.
8. Drilling fluid contamination test (Salt, Gypsum & Cement contamination) and their effect on the drilling fluid properties.
9. Measurement of solid and liquid content and emulsification characteristics of drilling fluid.
   Equipment: Sand content set, fann emulsion and electrical stability testers
10. Measurement of Oil, water, solid and clay content.
    Equipment: Oil/ water retort kit
11. Measurement of water ratios for Portland cement slurry.
    (Effect of water ratio on free water separation normal and minimum water content and thickening time)
    Equipment: The atmospheric consistometer
12. Measurement of specific gravity of cement slurry
    Equipment: specific gravity bottles

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13. Measurement of consistency of cement
    Equipment: vi-cat apparatus
14. Measurement of initial and final setting times of given cement slurry

15. Measurement of compressive strength of cement test moulds and effect of temperature and pressure on setting of the slurry.
    Equipment: Compressive strength testing machine

Outcomes:

The students are able to**:**

- Assess the quality of various muds and their applications in drilling safely accounting the desired parameters.
- Carry out consultation jobs for healthy construction of open oil / gas wells.

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INDUSTRY EXPLORATION PROJECT

II Year-II Semester	**L**	**T**	**P**	**C**
	1	**0**	**2**	**2**

Learning Objectives:

The students will be able to:

- Get in-depth understanding of role of petroleum engineering in a process industry.
- Gain familiarity with organizational structure, work environment & culture, anatomy of petroleum processes and equipment involved in a process industry.
- Interact with the teams of engineers and operating personnel in a process industry.
- Know the challenges in design, operation and production of a process industry.

Methodology:

The total students of a class are divided into small groups. Each group would be sent to a petroleum industry for 7 days. Preferably on each Saturday in a week of 6-8 students along with a Faculty member. The host petroleum industry provides a mentor (an experienced engineer). The students are expected to study all aspects of the industry under the guidance of the mentors (Faculty and Industry). At the end of the 7 day program each student should submit a report, which will be evaluated by a two-member team of faculty nominated by the Head of the Department.

OUTCOMES:

The students are able to:

- Get exposed to various professional activities in a petroleum industry.
- Judge the importance and relevance of various subjects in curriculum.
- Know the possible career options in a petroleum industry.
- Assess the scale of operations.
- Acquaint with different forms of technical communication

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SUMMER INTERNSHIP

Learning Objectives:
The main objective of the internship is to gain up-to-date, practical experience in the real-working situation, in contrast to information gained during studies concerning mainly theoretical background of petroleum engineering.

The students are guided (through the Industry representative) to learn the following aspects:

- Application of the engineering skills, learned in class room, in real world.
- Working as a team to deliver the results along with senior engineering professionals, technicians, managers etc.
- Working safely in industrial environment.
- Result oriented approach in plant operation, troubleshooting and engineering work.
- Present and / or report the work / project outcomes to various disciplines, departments & interest groups with confidence.

Every Student should undergo summer training (summer internship program) in a petroleum industry (like ONGC)/service providing industry (like Halliburton) for 4-6 weeks and submit a report.

Outcomes:
The students are able to:

- Work safely in industrial environment.
- Work with various interest groups, disciplines, professionals, managers and technicians etc.
- Polish the engineering skills by applying the practical knowledge in day-to-day operations, trouble-shooting and minor-modifications.
- Build relations between university and industry that helps mutual collaboration and cooperation over long-term.
- Develop/strengthen the basic skills of interviewing, analysis, report writing, communication, decision-making, and problem solving.

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HONORS/MINOR COURSES

II Year-II Semester	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

Learning Objectives:
The students are able to:

- Avail the expertise in a specific subject from nation-wide reputed faculty, through MOOC (Massive Open Online Course)
- Develop the ability for self-actualization and in getting opportunity for life-long learning

There shall be a Discipline Centric Elective Course through Massive Open Online Course (MOOC) as Program Elective course. The student shall register for the course (Minimum of 12 weeks) offered by SWAYAM/NPTEL through online. The course is selected in consultation with MOOCS coordinator/Mentor and with the approval of Head of the Department. During the course, the coordinator monitors the student's progress in the SWAYAM/NPTEL courses.

The students need to submit all the assignments given and take final exam. Each student has to earn a certificate by passing the exam. Each student will be awarded the credits given in curriculum only after submission of the certificate. If student does not pass the subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered and studied again through SWAYAM/NPTEL in the next semester to submit the certificate.

The list of MOOCS/department courses is given in appendix to do honors in petroleum engineering. The eligible student is expected to choose the subjects from the list. To fulfill the criteria of qualifying for honors degree, **16 credits** should be obtained at the end of final semester. In order to get minor degree, a student has to do the courses in any one discipline other than petroleum engineering to fulfil the criteria of 16 credits.

The total **16 credits** for honors or minor degree should be obtained from the fourth semester to the end of eighth semester. A candidate can take a 4-credit course in each semester during the above-mentioned period.
It may be noted that, each student is to get minimum 8.0 SGPA without any backlogs in each semester to do honors / minors degree.

Outcomes:
The students will be able to:

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- Overcome the digital divide in acquiring fast developing technologies / knowledge and be part of digital revolution.
- Acquire subject specific expert knowledge from National Resource Pool.
- Understand his /her academic / professional priorities for future development.

Learning objectives:

The student will be able to learn:

- The basic elements of an instrument and its static and dynamic characteristics.
- The various types of industrial thermometers.
- The various types of instruments for measurement of pressure, vacuum, head and density measurement.
- The behavior and logic of different types of advanced controllers and their strategies.
- The how Laplace transforms can be used to get solutions of transfer function equations for different types of systems.
- The basic procedure to derive transfer functions for first order, pseudo second order and second order systems.
- The importance of under damped second order systems in relation to the real life situations.
- The calculation of the overall transfer function and thus offset calculation from the control system block diagram.
- The concept of stability, stability criterion and frequency response analysis for sinusoidal forcing functions.
- The behavior and tuning of a controller and the calculation of controller parameters.
- The inherent and effective characteristics of different types of control valves and the usage of valve positioners to induce linear characteristic into a non-linear control valve.

UNIT-I:

Fundamentals: Elements of instruments, static and dynamic characteristics of instruments.

Industrial Thermometers**:** Mercury in glass thermometer - Bimetallic thermometer - Pressure spring thermometer, Thermo-electricity – types of thermocouples – Thermocouple lead wires. Resistance-thermometers: RTD and bridge circuits (2 wire, 3 wire and 4 wire - method) -Radiation receiving elements- pyrometers.

UNIT-II:

Pressure, vacuum and head: Liquid column manometers - Measuring elements for gauge pressure and vacuum-indicating elements for pressure gauges - Measurement of absolute pressure - Measuring pressure in corrosive liquids - Static accuracy and response of pressure gauges.
Density and specific gravity measurements- Direct measurement of liquid level - Pressure measurement in open vessels - Level measurements in pressure vessels - Measurement of interface level - Density measurement and level of dry materials.

UNIT-III:
Introduction to process dynamics and control, Response of First Order Systems, Physical examples of first order systems.
Response of first order systems in series, higher order systems: Second order and transportation lag. Control systems Controllers and final control elements.

UNIT-IV:
Closed loop transfer functions, Transient response of simple control systems.
Stability: Stability Criterion, Routh Test, Root locus, Introduction to frequency response, Bode stability criterion, concept on gain and phase margins

UNIT-V:
Advanced control strategies: Cascade control, Feed forward control, ratio control, dead time compensation, internal model control.
Controller tuning and process identification. Control valves.

Outcomes:
The students are able to:

- Analyze the basic elements of an instrument and its characteristics.
- Measure the various process variables using the appropriate types of instruments process variables (temperature, pressure, flow rate, composition, pH, viscosity, density, dry bulb and wet bulb temperatures).
- Apply the partial fractions and Laplace transforms for converting ordinary differential equations into simple algebraic equations which are easier to solve.
- Write the different types of unsteady and steady state balances.
- Describe processes with appropriate block diagrams.
- Model a process numerically.
- Identify the stability limits of a system.
- Apply the advance control strategies.
- Tune the process controllers.

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- Experimentally determine the dynamic behavior of a process.
- Design and operate control valves.

Text Book:

3. Industrial Instrumentation, Donald P. Eckman, CBS, 2004.
4. Process Systems Analysis and Control, D.R. Coughanowr, 3rd Ed. McGraw Hill

Reference Books:

1. Chemical Process Control, G. Stephanopoulos, Prentice Hall, 1984.
9. Coulson and Richardson's Chemical Engineering, Volume-3, 3rdEdition: Chemical and Biochemical Reactors and Process Control, Richardson J. F. et.al, Elsevier India, 2006.
10. Automatic Process Control, Donald P. Eckman, John wiley, Reprint 2011.
11. Instrumentation and Control Systems, K. Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016.
12. Process Dynamics and Control, Dale Seaborg, Thomas F. Edgar, Duncan Mellichamp, 2ndEdition, Wiley India Pvt. Ltd., 2006.
13. Principles of Process Control. Patranabis, 3rdEdition McGraw-Hill Education Pvt. Ltd., 2012.
14. Modern Control Engineering, Katsuhiko Ogata, 5th Edition, Prentice Hall, 2010.
15. Principles and Practices of Automatic Process Control, Carlos A. Smith, Armando B. Corripio, 3rd International Edition, John Wiley and Sons, 2005.

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III Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
PETROLEUM EXPLORATION					

Learning Objectives:
The students will be able to learn:

- The fundamentals of petroleum exploration.
- The sedimentology and biostratigraphy to understand the sedimentary sequences holding hydrocarbons.
- The exploration history in India.
- The basic methods which are used in petroleum exploration with special emphasis on gravity/magnetic.
- The Seismic methods which are the back bone of the whole gamut of oil exploration.
- The scenario of future of petroleum industry.

UNIT-I:
Introduction: Overview of petroleum exploration in India, Introduction to Geophysical/Geological methods used in petroleum exploration.
Sedimentological methods in hydrocarbon exploration biostratigraphic methods in hydrocarbon exploration.

UNIT-II:
Basic concepts of Gravity/Magnetic methods: Newton's gravitational law- Units of gravity-Gravity measuring instruments- Gravity survey- Gravity anomalies- Gravity data reduction-Drift- latitude- Elevation and free air correction- Free air & bouguer anomalies- Gravity response of simple shapes- Interpretation of gravity anomalies- Application of gravity methods.

UNIT-III:
Magnetic survey: The geomagnetic field- Magnetic anomalies- Magnetic survey-instruments- Field method of magnetic surveys- Reduction of magnetic data - Diurnal correction and geomagnetic correction- Interpretation of magnetic anomaly- Response of magnetic method for different type of bodies and geological structure- Application of magnetic surveys both overland and from air.

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UNIT-IV:

Basic Concepts of seismic methods and refraction surveys: Seismic refraction surveys- Geometry of refracted path, planar interface – Two-layer case with horizontal interface- Methodology of refraction profiling- Recording instruments & energy sources- Corrections applied to refraction data, Interpretation of refraction data - Application of seismic refraction method.

UNIT-V:

Reflection seismic methods: Single horizontal reflector- The reflection seismograph and seismogram (Seismic traces)- Importance of seismic reflection survey over seismic refraction survey technique- Common depth point (CDP) profiling and stacking- 2D, 3D, & 4D seismic surveys - Field procedures and principles - Time corrections applied to seismic data- Data processing - Introduction to 2D, 3D & 4D data acquisition, interpretation of reflection data for identification of drillable structures.

Outcomes:

The students are able to:

- Analyse the physics and geology, which form the basics of different geophysical measurements.
- Apply the skills developed in this course to different problems facing in search for hydrocarbons.
- Analyse the basic principle of geophysical methods in different exploration methods specifically seismic, gravity and magnetic.
- Process 2D, 3D, and 4D from reflection data for identification of drillable structures.
- Interpret 2D, 3D, and 4D seismic data to fine-tune the reservoir model.
- Develop a reservoir model in the exploration of hydrocarbon with different geophysical measurements.

Text Books:

1. Introduction to Geophysical Prospecting, Milton B. Dobrin, and Carl H. Savit, 4th Edition, McGraw Hill, 1988.
2. Outlines of Geophysical Prospecting: A Manual for Geologists, M.B. Ramachandra Rao, EBD Educational Pvt. Ltd., 1993.
3. Field Geophysics, John Milsom and Asger Eriksen, 4th Edition, John Wiley, 2011.

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Reference Books:

1. Elements of Geology: Oil and Gas Exploration Techniques, J. Guillemot, Technip 1991.
2. Hydrocarbon Well Logging Recommended Practice, Society of Professional Well Log Analysts.
3. Open – Hole Log Analysis and Formation Evaluation, Richard M. Batemons, International Human Resources Development Corporation, Bostan, 1985.
4. Well Logging for Earth Scientists, Darwin V. Ellis, Julian M. Singer, Springer, 2007.
5. Fundamentals of Well Log Interpretation: The Acquisition of Data, Oberto Serra, Elsevier, 1984.
6. Well Logging Handbook, Oberto Serra, Editions Technip, 2008.

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III Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
WELL LOGGING & FORMATION EVALUATION					

Learning objectives:
The students will be able to learn:

- The basic concepts of logging.
- The presence of hydrocarbons through different logging methods.
- The concepts of formation lithology through logs like S.P, G.R etc. and also depositional environment with the help of Gamma ray spectroscopy and Dip-meter tools.
- The physical properties of the subsurface strata like resistivity, porosity, thickness etc. through tools like latero logs, induction, density, neutron, etc.
- The calculation of hydrocarbon saturation using the data acquired by different logging tools.
- The estimation of hydrocarbons reserves in formations.
- The interpretation of log data with the help of advanced technology tools namely, Scanner, NMR, Modular formation tester etc.

UNIT-I
Concepts of Well Logging: What is well logging? - logging terminology - borehole environment - borehole temperature and pressure - log header and depth scale-major components of well logging unit and logging setup- classification of well logging methods-log presentation- log quality control.
Direct Methods: Mud logging- preparation of litho logs - coring – conventional and sidewall coring - core analysis.

UNIT-II
Open Hole Logging: SP Logging- origin of SP, uses of SP log-calculation of salinity of formation water- shaliness - factors influence SP log.
Resistivity Log: Single point resistance log (SPR)- conventional resistivity logs-response of potential and gradient logs over thin and thick conductive and resistive formations - limitations of conventional resistivity tools. Focused resistivity log-advantages of focused resistivity tools over conventional resistivity tools.
Micro-Resistivity Log: Conventional and focused micro resistivity logs and their application.
Induction Log: Principle of induction tool and the advantages, criteria for selection of induction and lateral logging tool, determination of true resistivity (Rt) of the formation - resistivity index - Archie's equation.

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UNIT-III

Gamma Ray Log: principle of radioactivity - uses of gamma ray log- determination of shaliness of formation-API counts- calibration of gamma ray tool - statistical fluctuation- time constant.

Natural Spectral Gamma ray log: Principle and application.

Caliper Log: Principle and application of caliper tool.

Density Log: Principle of density tool- environmental corrections - porosity determination - tool calibration, litho density log.

Neutron Log: Principle and application of neutron tool, porosity determination.

Sonic Log: Principle and application of sonic log - bore hole compensation - determination of primary and secondary porosity, determination of mechanical properties of rock, elastic constants, fractures etc.,

UNIT-IV

Cased Hole Logging: Gamma ray spectral log - neutron decay time log - determination of fluid saturation behind casing - cement bond log - casing collar log - depth control - free point locater - casing inspection logs.

Production Logging: Solving production problems with the help of fluid density log - temperature log and flow meter logs.

UNIT-V

Advances in Well Logging: Dip meter log - formation tester - cased hole resistivity logs -nuclear magnetic resonance log & scanner logs (sonic scanner, MR scanner RT scanner)- Image logs, Calculating the dip of the formations, collection of fluid samples from wells for confirmation of log interpretation, and also recording resistivity in cased holes.

Interpretation: Quick look interpretation - cross plots. Neutron - density, sonic - density, sonic - neutron cross plots - Hingle plot - mid plot – correlation - hydrocarbon reserve estimate. Discussion of case studies and trouble shooting.

Outcomes:

The students are able to:

- Apply the basic concepts of logging.
- Preparation of litho logs.
- Assess hydrocarbons through direct and indirect logging methods.
- Apply the concepts to determine the formation lithology through logs like S.P, G.R etc. and also depositional environment with the help of Gamma rays spectroscopy and Dip-meter tools.
- Calculate the physical properties of the subsurface strata like resistivity, porosity, thickness etc. through tools like latero, induction, density, neutron, etc.

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- Calculate hydrocarbon saturation using the data acquired by different logging tools.
- Estimate the hydrocarbons reserves in a particular formation.
- Interpret the log data with the help of different logging tools.

Text Books:

1. Formation Evaluation, Edward J. Lynch, Harper & Row, 1962.
2. Well Logging and Formation Evaluation, Toby Darling, Elsevier, New York, 2005.
3. Well Logging & Reservoir Evaluation, Oberto Serra, Editions Technip, 2007.

Reference Books:

1. Basic Well Logging and Formation Evaluation, Prof. Dr. Jurgen Schon, First Edition, Bookboon publishers, 2015.
2. Hydrocarbon well logging recommended practice, Society of professional well log analysts.
3. Open – Hole log analysis and formation evaluation, Richard M. Batemons, International
4. Human Resources Development Corporation, Bostan, 1985.
5. Well Logging for Earth Scientists, Darwin V. Ellis, Julian M. Singer, Springer, 2007.
6. Fundamentals of Well Log Interpretation: The Acquisition of Data, Oberto Serra, Elsevier, 1984.
7. Well Logging Handbook, Oberto Serra, Editions Technip, 2008.

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III Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
PETROLEUM RESERVOIR ENGINEERING-I					

Learning Objectives:
The students will be able to learn:

- The basic concepts in reservoir engineering
- The PVT analysis for oil & gas reservoirs
- Material balance applied to oil & gas reservoirs
- Darcy's law and its applications
- Development of diffusivity equation and its solutions
- The well inflow estimation for stabilized flow conditions.

UNIT-I
Basic concepts in reservoir engineering: Calculation of hydrocarbon volumes- Fluid pressure regimes- Oil recovery and recovery factor -Volumetric gas reservoir engineering – Application of the real gas equation of state - Gas material balance and recovery factor and its conceptual coherence with drive mechanisms - Hydrocarbon phase behavior.

UNIT-II
PVT analysis for oil: Definition of the basic PVT parameters – Collection of fluid samples - Determination of the basic parameters in the laboratory and conversion for field operating conditions - Alternative manner of expressing PVT lab analysis results - Complete PVT analysis.

UNIT-III
Material balance applied to oil reservoirs: General form -The material balance expressed as a linear equation - Reservoir drive mechanisms - Solution gas drive- Gas cap drive- Natural water drive- compaction drive and related pore compressibility phenomena.

UNIT-IV
Darcy's law and applications: Darcy's law and field potential- Sign convention- Units and unit conversion- Real gas potential – Datum pressures- Different flow regimes- Linear &Radial steady state flow - Pseudo-steady flow- Unsteady state flow- Derivation of deliverability equations – estimation of reservoir permeability - Two phase flow- Effective and relative permeabilities.

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UNIT-V

Radial Diffusivity Equation: The basic differential equation for radial flow in a porous medium- Derivation of the basic radial differential equation – Conditions of solution – The linearization of the equation for slightly compressible and highly compressible fluids -Application of dimensionless diffusivity equation – Numerical solutions using Excel Macros and MAT lab.

Well inflow estimation for stabilized flow conditions: Semi steady state solution – Steady state solution – Example of the application of the stabilized inflow equations – Generalized form of inflow equation under semi steady state conditions.

Outcomes:

The students are able to:

- Apply the basic concepts in reservoir engineering.
- Perform basic PVT analysis of various types of fluids for wells.
- Carry out the calculations in material balance and estimate the reserves of various sands of the reservoir from well data.
- Apply the Darcy's Law and derive deliverability equations for various types of reservoirs.
- Develop diffusivity equation and its solutions
- Calculate the formation damage and can recommend suitable stimulation operations to revive the wells.
- Compute the flow rates of oil and gas from stabilized inflow equations.

Text Books:

1. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17th Impression 1998).
2. Applied Petroleum Reservoir Engineering, B. C. Craft – M. Hawkins, Third Edition, Revised by Ronald E. Terry & J. Brandon Rogers, Prentice Hall, New York, 2014.

Reference Books:

1. Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing, 2006.
2. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham &Trotman Inc. 1986.
3. Basic Reservoir Engineering, Rene Cosse, Editions Technip, 1993.

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4. Petroleum Reservoir Engineering, James W. Amyx, Daniel M. Bass Jr., Robert L. Whiting, McGraw Hill, 1960.
5. Practical Reservoir Engineering and Characterization, Baker, R – Harvey W. Y and Jensen, J. L. Elsevier, GPP, 2015

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III Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
INTRODUCTION TO PETROLEUM ENGINEERING (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The basic concepts that will enable the transition from petroleum science to petroleum engineering.
- The role of petroleum engineers in upstream, midstream and downstream sectors.
- The fundamental concepts of upstream, midstream and downstream sectors.
- The transportation of crude oil & its products and natural gas.

UNIT-I
Introduction: What is Petroleum Engineering and its Significance? Introduction to Petroleum Industry- Upstream Sector – Midstream Processing-Downstream Processing- Indian and World Scenario of Petroleum and Natural Gas- Petroleum Trade- Geopolitics.

UNIT II
Upstream Sector-1: Exploration & Production – Indian and World Scenario of Petroleum and Natural Gas Resources.
The Reservoir –Reservoir fluids- Hydrocarbon Phase diagrams- Onshore and Offshore Reservoirs – Reservoir Drives.

UNIT III
Upstream Sector-2: Drilling Rigs- Rig Components-Drill and drill bits- Drilling fluids-Well Completions.
Production System: Sketches of Well - Well head- Christmas tree and Casing and various other parts- Cementing-Safety Systems.
Subsea Wells: Drilling & Completion and Production.
Artificial Lift: Principles and operation of Rod Pumps –Gas Lift –Electrical submersible pumps.
Well Workover and Intervention- Well Stimulation: Basic concepts in Matrix Acidizing and Hydro-fracturing.

UNIT IV

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Gathering of Oil & Gas and Storage:

Well Tubing- Separation of Reservoir Fluids- Manifolds and Gathering – Production Separators – Gas Treatment and Compression - Oil & Gas Storage, Metering and Export.

Midstream processing: Transportation of Crude Oil & its Products and Natural Gas - World and Indian pipeline scenario- Design of Oil and Gas pipelines - Safety aspects of pipelines- Environmental issues.

UNIT V

Downstream Processing:

Crude Oil Refining: Classification and Composition – Constituents - Products and their specifications– Pre-treatment of crude oil- Refinery distillation- Safety in refinery operations.

Outcomes:

The students are able to:

- Analyse the role of petroleum engineers in various facets of petroleum exploration, production, transportation, refining and processing.
- Apply the concepts of exploration, drilling, well completions, production system, subsea wells and workover operations.
- Apply the basic concepts of reservoir engineering.
- Apply the basic concepts of tube design, separator design, manifold design for oil & gas gathering and the design for storage system, metering and export.
- Design of transportation pipelines for crude oil & its products and natural gas.
- Apply the concepts of petroleum refining in the design and operation of a refinery.

Text Books:

1. Oil and Gas Production Handbook: An Introduction to Oil & Gas Production, Havard Devold, ABB ATPA Oil and Gas, 2006.
2. Introduction to Petroleum Engineering, John R. Fanchi and Christiansen, R.L., John Wiley & Sons, 2017.

Reference Books:

1. Petroleum engineering handbook: Howard.B. Bradley,SPE,1987
2. Petroleum engineering hand book: Larry .W.lake, SPE, volume II, 2006.
3. Petroleum engineering handbook: Production operations engineering, volume IV, Joe Dunn Clegg, 2009.

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		3	**0**	**0**	**3**
SAFETY IN PETROLEUM OPERATIONS (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The various petroleum operations and terms used in petroleum safety.
- The significance of oil mine regulations.
- The duties and responsibilities of deputy manager, safety officer, general management, contractors.
- The classification of fires and the protection against gases and fires, plants and equipment.
- The electrical safety, personnel safety, general safety and permit systems.
- The safety measures in petroleum operations.

UNIT-I
Introduction to Petroleum operations: Brief description of petroleum operations.
Terms used in Petroleum safety: Nomenclature, definitions, abbreviations and terms.
Inspectors, Management and Competent Persons: Qualification of inspector, definition of mine - qualification and appointment of deputy manager, installation manager, safety officer - general management.

UNIT-II
Safety in electrical equipment: Classification of hazard area, safety in installation of electrical equipment.
General safety measures: Personal protection measures, housekeeping and general safety – protection against noise, safety while working at heights, safety warnings - industrial air pollution control equipment- permit systems - safety management plan.

UNIT-III
Oil Mines Regulations: Returns, notices and plans- inspector, management and duties - drilling and workover – production - transport by pipelines - protection against gases and fires - machinery, plants and equipment- general safety provisions – miscellaneous - remediation of contaminated sites- site assessment-remediation process.

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UNIT-IV

Duties And Responsibilities of Management, Contractors, Manufactures, Competent Persons and Workmen: Duties and responsibilities of owner, general responsibilities of supplier - manufacturer and designer - duty of persons employed in mine - duties and responsibilities of manager - deputy manager, installation manager - safety officer - fire officer - competent persons.

UNIT-V

Classification of Fires: The fire triangle - distinction between fires and explosions - flammability characteristics of liquids and vapors - well blowout fires and their control - fire fight equipment - suppression of hydrocarbon fires.

Safety measures in petroleum Operations: Drilling and workover - Wireline fishing- Fishing operations- Well Completions- Well Testing- pumps and compressors- Group Gathering Operations- Well servicing operations- Artificial lift Techniques- Matrix Acidizing-Hydro-fracturing-Safety valves– SSV,SCSSV,TRSSV-Pipeline Transport – High pressure and High temperature operations – Oil spills.

Outcomes:

The students are able to:

- Assess various petroleum operations and terms used in petroleum safety.
- Assess the significance of oil mine regulations.
- Distinguish duties and responsibilities of deputy manager, safety officer, general management, contractors.
- Classify fires and implement the protection measures.
- Apply electrical safety, personnel safety, and general safety and permit systems in petroleum industry.
- Assess the safety measures in petroleum operations.

Text Book:

1. Oil mines regulations, Directorate General of Mines Safety, Ministry of Labor and Employment, Government of India, 2017.

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Reference Books:

1. Directorate General of Mines Safety, Ministry of Labor and Employment, Government of India,
2. Oil Industry Safety Directorate (OISD) Guidelines, Ministry of Petroleum & Natural Gas, Government of India.
3. Guidelines for Fire Protection in Chemical, Petrochemical and Hydrocarbon Processing Facilities, Centre for Chemical Process Safety, American Institute of Chemical Engineers, 2003.
4. Daniel Crawl, Joseph Louvar, Chemical process safety: Fundamentals with applications, 4th Edition, Pearson, 2019.

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		3	**0**	**0**	**3**
CORROSION CONTROL IN PETROLEUM INDUSTRY (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The fundamentals of electrochemistry and material science relevant to corrosion phenomena.
- The mechanisms and causes of various types of corrosion.
- The methods for predicting, measuring, and analyzing corrosion performance of materials.
- The practices for the prevention and remediation of corrosion.
- The evaluation methods of various corrosion resistant materials for the application in oil and gas industry.

UNIT-I
Introduction to Oilfield Chemistry and Corrosion: Fundamentals of oilfield chemistry including corrosion chemistry.
Classification of corrosion: General corrosion, localized corrosion, MIC, FAC, SCC, CO_2 and H_2S corrosion.
Thermodynamics of electrochemical corrosion: Pourbaix and Evans diagrams, electrochemical reactions, polarization and corrosion rate calculation and measurement. Corrosion tests and standards.

UNIT-II
Advanced Oilfield Corrosion: Introduction to coating and corrosion protection, role of oxygen in oilfield equipment, CO2 and H_2S corrosion mechanisms in oilfield environments, role of pressure and salinity on corrosion rates - review and application of CO_2 corrosion models, microbiological induced corrosion in oil field, Pipeline corrosion monitoring, inspection and control strategies - applications to Oil & Gas industry, mitigation of corrosion with inhibitor applications, corrosion inhibitor evaluation.

UNIT-III
Materials Selection: In service failure modes; methodologies of materials and process selection in structural and functional design: qualitative and quantitative; materials specification and sourcing: alloy designations and materials equivalences;

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databases and materials information sources; Maintenance, monitoring and lifetime predictions

UNIT-IV

Failure Analysis: Approach to failure analysis; tools of failure analysis; fractography- mechanical failure, environmental effects; characteristics of fracture; weld failure; failure of polymers, ceramics and composites: special features of mechanical failure and environment.

Failure prevention: Design codes and inspection procedures; failure in electronic components and devices; case studies relevant to the individual programme of study.

UNIT-V

Metals and Alloys: Phase diagrams and phase equilibria; metallic crystal structures and microstructure; mechanical properties, deformation and strengthening mechanisms - applications to oil & gas industry.

Outcomes:

The students are able to:

- Assess the concepts of electrochemistry and materials science relevant to corrosion phenomena.
- Assess the causes of mechanisms of various types of corrosion.
- Apply the methods for predicting, measuring, and analyzing corrosion performance of materials.
- Implement the practices for the prevention and remediation of corrosion.
- Evaluate the various corrosion resistant materials for the application in oil and gas industry.

Text Books:

1. Corrosion engineering, Mars G. Fontana McGraw-Hill, 1967, ISBN: 007021460.
2. Principles and prevention of corrosion, Denny A Jones, 2nd edition, Prentice Hall, N. J. 1996.
3. Corrosion and corrosion control, H. H. Uhlig and R. W. Revie Wiley (NY), 1987.
4. Corrosion, L. Shreir Vol I and II, Butterworths, Kent 1976.

Reference Books:

1. Atlas of Electrochemical Equilibrium in aqueous solutions, M. Pourbaix NACE, Houston 1974.
2. Modern Electro chemistry, J. O. M. Bockris and A. K. N. Reddy Vol I and II, Plenum Press (NY).

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3. Microbial Aspects of Metallurgy, J. D. A. Miller, Medical and Tech. publishing, 1971.

III Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

FUNDAMENTALS OF LIQUEFIED NATURAL GAS
(PROFESSIONAL ELECTIVE)

Learning Objectives:
The students will be able to learn:

- The basic knowledge of LNG and its perspectives.
- The classification and description of liquefaction technologies of LNG and support processes.
- Different functional units on receiving terminals.
- Marine transportation of LNG and its re-gasification at the terminals.
- The HSE procedures employed in LNG industry.

UNIT-I:
Introduction: Overview of LNG industry: History of LNG industry – Base load LNG – Developing an LNG Project – World and Indian Scenario – Properties of LNG.
Supporting Functional Units in LNG Plants: Gas pretreatment: Slug catcher – NGL stabilization column – Acid gas removal unit – Molecular sieve dehydrating unit – Mercury and sulfur removal unit – NGL recovery – Nitrogen rejection – Helium recovery.

UNIT-II:
Liquefaction Technologies: Propane precooled mixed refrigerant process – Description of Air Products C_3MR LNG process – Liquefaction – LNG flash and storage.
Cascade process: Description of Conoco-Phillips Optimized Cascade Process – Liquefaction – LNG flash and storage.
Other Liquefaction Processes: Different process technologies for LNG production - Precooling and Liquefied Petroleum Gas (LPG) recovery – thermodynamics of liquefaction and sub cooling- Trends in LNG train capacity – strategy for grassroots plant- offshore LNG production.

UNIT-III:
Receiving Terminals: Receiving terminals in India – Main components and description of marine facilities – design of storage tanks – Process descriptions.
Integration with adjacent facilities – Gas inter changeability – Nitrogen injection – Extraction of C_{2+} components.

UNIT-IV:

LNG Shipping Industry & Major Equipment in LNG Industry:

LNG Shipping Industry: LNG fleet – Types of LNG ships – Moss – Membrane – prismatic; Cargo measurement and calculations.

Major equipment in LNG industry – Cryogenic heat exchangers: Spiral – Wound heat exchangers – Plate & fin heat exchangers – Cold boxes; Centrifugal compressors – Axial compressors – Reciprocating compressors.

LNG pumps and liquid expanders – Loading Arms and gas turbines.

UNIT-V:

Vaporizers: Submerged combustion vaporizers- Open rack vaporizers – Shell and tube vaporizers: direct heating with seawater, and indirect heating with seawater.

Ambient air vaporizers: Direct heating with ambient air – Indirect heating with ambient air- LNG tanks.

Safety, Security and Environmental Issues: Safety design of LNG facilities – Security issues for the LNG industry – Environmental issues – Risk based analysis of an LNG plant.

Outcomes:

The students are able to:

- Screen and apply latest technologies and techniques in the LNG industry.
- Carry out preliminary design and operate a plant for liquefaction of natural gas including other support processes.
- Plan and carry out preliminary design and operate re-gasification terminals.
- Carry out preliminary design of LNG heat exchangers and vaporizers.
- Assess the requirements for LNG marine transport and storage.
- Apply the safety, security and environmental Issues for the LNG industry.

Text Book:

1. LNG: Basics of Liquefied Natural Gas, I Edition, Stanley Huang, Hwa Chiu and Doug Elliot, PETEX, 2007.
   https://ceonline.austin.utexas.edu/petexonline/file.php/1/ebook_demos/lng/HTML/index.html

Reference Books:

1. LNG handbook, Saeid Mokhatab et.al., Gulf publishing,2014.
2. Marine Transportation of LNG (Liquefied) and Related Products, Richard G. Wooler, Gornell Marine Press, 1975.
3. Natural Gas by Sea: The Development of a New Technology, Roger Rooks, Witherby, The book services limited, 1993.

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4. LNG: A Nontechnical Guide, Michael D'Tusiani, Gordon Shearer PennWell, 2007.
5. Natural Gas Transportation, Storage and Use, Mark Fennell, Amazon Digital Services, Inc., 2011.
6. Liquefied Natural Gas, Walter Lowenstein Lom, Wiley 1974.
7. Liquefied Natural Gas, C. H. Gatton, Noyes, 1967.
8. Liquefied Gas Handling Principles: On Ships and in Terminals, Barry white, Graham McGuire, 3rd Edition, Witherby, 2000.

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		3	**0**	**0**	**3**
CBM RESERVOIR ENGINEERING (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The overview of Coal Bed Methane.
- The concepts on the geology of coal.
- The basic principles of sorption and isotherms.
- The methods of well logging in CBM wells.
- Characterization of CBM reservoirs.
- The estimation of CBM reserves.
- The concepts of drilling, completions and production of CBM.
- The best practices of hydro fracturing of CBM wells.
- The HSE concepts involved in CBM production and disposal of produced water.

UNIT-I
Introduction: Overview of coal bed methane (CBM) in India – CBM vs Conventional Reservoirs. Geological influences on cleat formation of coals – Coal chemistry – Significance of rank – Cleat system and natural fracturing.

UNIT-II
Sorption: Principles of Adsorption-The Isotherm construction-CH_4 retention by coal seams-CH_4 content determination in coal seams-The isotherm for recovery - prediction - Model of the micro-pores-coal sorption of other molecular species. **Reservoir Analysis:** Coal as a reservoir - Permeability-Porosity-Gas flow-Reserve analysis-Well spacing and drainage area- dewatering mechanism - Enhanced recovery.

UNIT-III
Well Construction: Drilling-Cementing, Formation Evaluations, Logging: Borehole environment -Tool measurement response in coal-wire line log evaluation of CBM wells -Gas-In-Place calculations -Recovery factor -Drainage area calculations - Coal permeability/Cleating-Natural fracturing and stress orientation -Mechanical rock properties in CBM evaluation.

UNIT – IV
Completions: Open hole completions -Open hole cavitation process, Cased hole completions- Multi zone entry in cased hole.

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UNIT-V

Hydraulic fracturing of coal seams: Need for fracturing coals - Unique problems in fracturing coals - Types of fracturing fluids for coal-In situ conditions - Visual observation of fractures.

Water production and disposal: Water production rates from methane wells - chemical content - environmental regulations - water disposal techniques - economics of coal bed methane recovery - application of CO_2 sequestration.

Outcomes:

The students are able to:

- Assess the Coal Bed Methane reservoirs in the world and India.
- Apply the basic concepts on the geology of coal.
- Apply the basic principles of sorption and isotherms in estimating CBM per ton of coal.
- Use the methods of well logging in CBM wells.
- Characterize CBM reservoirs.
- Estimate CBM reserves.
- Apply the concepts of drilling, completions and production for CBM reservoirs.
- Implement best practices of hydro fracturing for CBM wells.
- Practice the HSE concepts for CBM operations and disposal of produced water.

Text Books:

1. Fundamentals of Coal Bed Methane Reservoir Engineering, John Seidle, Pennwell Corp., 2011.
2. Coal Bed Methane: Principles and Practice, R. E. Rogers, 3rd Edition, Prentice Hall, 1994.
3. Coal Bed Methane, Robert A. Lamarre, American Association of Petroleum Geologists, 2008.

Reference Books:

1. Coal Bed Methane, Society of Petroleum, 1992.
2. A Guide to Coal Bed Methane Operations, B. A. Hollub, Society of Petroleum, 1992.

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III Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
OFFSHORE DRILLING (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The concepts of offshore oil and gas operations.
- The design aspects of Offshore fixed platforms and mobile units.
- The concepts of offshore drilling and well completions.
- The advanced drilling techniques.
- The basics of Deep water technology, Divers and Safety.

Unit -I
Introduction to offshore oil and gas operations:
Introduction to offshore oil and gas operations-Sea states and weather: Introduction to Meteorology, Oceanography, Ice, Sea bed oil-Buoyancy and stability.

Unit -II
Offshore fixed platforms and mobile units:
Offshore fixed platforms: Types, descriptions and operations- Offshore mobile units: Types description and installation, Station keeping methods like conventional mooring and dynamic positioning system.

Unit -III
Offshore drilling and well completions:
Difference in drilling from land, from fixed platform, Jackup, ships and semi submersibles. Use of conductors and risers. Deep sea drilling, Platforms and subsea completions, Deep water applications off subsea technology.

Unit IV
Advanced Drilling Techniques:
Direction drilling-Applications, Horizontal wells, MWD, LWD and ERD wells drilling techniques and tools.

Unit V
Deep water technology, Divers and Safety:
Introduction, Definition and prospects- Deep water regions, Deep water drilling rig-Selection and deployment, Deep water production system, Emerging deep water technologies- special equipment and system, Remote operation vessels (ROV),

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Member	Member	Member

Principles of diving, Use of decompression chambers, life boats-Offshore environmental pollution and remedial measures

Course outcomes:

The students are able to:

- Apply the concepts of offshore oil and gas operations.
- Implement the design aspects of offshore fixed platforms and mobile units.
- Apply the concepts of offshore drilling and well completions.
- Assess the requirements of advanced drilling techniques.
- Apply the basics for Deep water drilling.
- Implement HSE aspects of offshore and deep water drilling.

Text books:

1. Sukumar Laik, Offshore Petroleum Drilling and Production, CRC Press.1st Edition, 2020.
2. DRIL-QUIP Inc., Offshore Drilling and completions Training, 1996.

Reference books:

1. Offshore Oil Drilling, Nick Hunter 1st Edition, Heinemann educational books, 2012.
2. Offshore Drilling Industry and Rig Construction in the Gulf of Mexico, Mark J. Kaiser, Brian F. Snyder Springer, 2013.
3. Offshore Oil and Gas People, Amanda Barlow Createspace independent publishers, 2017.
4. Drilling and Producing Offshore, R. Stewart Hall 1st edition, Penn Well, 1983.
5. ETA Offshore seminars, Inc., The Technology of Offshore Drilling, Completion and Production, Penn Well, 1976.
6. Offshore Drilling and Production Equipment, S. Tanaka, Y. Okada, Y. Ichikawa, EOLSS publishers, UK, 2005.

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III Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
PETROLEUM RESERVOIR ENGINEERNG LABORATORY					

Learning Objectives:
The students will be able to learn:

- Experimental determinations of reservoir (Oil as well as gas) properties such as saturation, porosity, absolute & relative permeability.
- Capillary pressure, fluid properties like density, viscosity and surface tension.

List of Experiments:

1. Determination of effective porosity by gas expansion method.
   Equipment: Helium Porosimeter.
2. Determination of porosity and pore size distribution by mercury injection.
   Equipment: Mercury Porosimeter.
3. Measurement of surface tension & interfacial tension with the ring Tensiometer.
   Equipment: Tensiometer.
4. Determination of fluid density using Pycnometer and hydrometer methods.
   Equipment: Pycnometer and hydrometer.
5. Liquid viscosity measurement using capillary tube viscometer (Ostwald type).
   Equipment: Capillary tube viscometer.
6. Determination of capillary pressure of reservoir rock (core) using porous plate method.
   Equipment: Capillary pressure cell.
7. Measurement of contact angle (between oil, water and solid surface) using imaging method.
   Equipment: The image system set-up.
8. Measurement of absolute permeability.
   Equipment: Constant head Permeameter with the Hassler cell.
9. Absolute permeability measurement using core flooding.
   Equipment: The Darcy apparatus.
10. Determination of relative permeability of oil-water using unsteady state method.
    Equipment: Relative permeability apparatus.
11. Determination of relative permeability of gas-oil using unsteady state method.
    Equipment: Relative permeability apparatus.

Outcomes:
The students are able to:

- Perform experiments to measure, interpret the reservoir rock and fluid property data.
- Assess the reservoir performance using the experimental data.

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		0	**0**	**3**	**1.5**
DRILLING SIMULATION – LABORATORY					

Learning Objectives:
The students are able to learn:

- The normal drilling operations as well as abnormal conditions in drilling.
- The prevention of abnormal conditions like Wall kicks, Blowouts, Mud losses etc.
- The concepts of how to handle the BOP, Panels, Choke manifold, remote panel etc., in case of any emergency situation.
- The Well shut in procedures and effect of properties of drilling fluids.
- The sensitivity analysis for drill bit penetration.

The following experiments are to be carried out using a drilling simulator:

1. **Familiarization and line-up of operational components – I**: Sand pipe manifold, draw work console, drilling console.
2. **Familiarization and line-up of operational components – II:** Blow out preventer (BOP) panel, remote panel.
3. **Familiarization and line-up of operational components – III:** Choke manifold.
4. **Operation of major components – I:** Mud pumps, operating slow circulation rate, operating the rotary table,
5. **Operation of major components – II:** Pulling weight on bit running in and pulling out of hole, remote choke panel operating.
6. **Kick identifications:** Setting flow alarms (deviation mud volume), setting flow alarms for return mud volume, identifying kick warning signs.
7. **Well shut in procedures:** Utilizing shut in procedures to kill well, well control computations.
8. Studies on the effect of weight on drill bit and rotary speed on the rate of penetration and wear of the bit.
9. Studies on the effect of mud density on the penetration and wear of the bit.
10. Studies on the effect of flow rate on the penetration and wear of the bit.

Outcomes:
The students are able to:

- Assess the differences between normal drilling operations and abnormal conditions in drilling.

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- Prevent abnormal conditions like Wall kicks, Blowouts, Mud losses etc.
- Apply the concepts of handling the BOP, Panels, Choke manifold, remote panels etc., in case of any emergency situation.
- Apply the Well shut in procedures.
- Assess the properties of drilling fluids for effective drilling.
- Carry out sensitivity analysis for drill bit penetration.

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III Year - I Semester		**L**	**T**	**P**	**C**
		1	**0**	**2**	**2**
SOFT COMPUTING TECHNIQUES					

Course Objectives:

In the course the student will Learn soft computing concepts and techniques and foster their abilities in designing and implementing soft computing based solutions for real-world problems.

UNIT I

FUZZY SET THEORY: Introduction to Neuro – Fuzzy and Soft Computing, Fuzzy Sets, Basic Definition and Terminology, Set-theoretic Operations, Member Function Formulation and Parameterization, Fuzzy Rules and Fuzzy Reasoning, Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning, Fuzzy Inference Systems, Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Input Space Partitioning and Fuzzy Modeling.

UNIT II

OPTIMIZATION: Derivative based Optimization, Descent Methods, The Method of Steepest Descent, Classical Newton's Method, Step Size Determination, Derivative-free Optimization, Genetic Algorithms, Simulated Annealing, Random Search – Downhill Simplex Search.

UNIT III

ARTIFICIAL INTELLIGENCE : Introduction, Knowledge Representation, Reasoning, Issues and Acquisition: Prepositional and Predicate Calculus Rule Based knowledge Representation Symbolic Reasoning Under Uncertainity Basic knowledge Representation Issues Knowledge acquisition, Heuristic Search: Techniques for Heuristic search Heuristic Classification State Space Search: Strategies Implementation of Graph Search Search based on Recursion Patent-directed Search Production System and Learning.

UNIT IV

NEURO FUZZY MODELING: Adaptive Neuro-Fuzzy Inference Systems, Architecture – Hybrid Learning Algorithm, Learning Methods that Cross-fertilize ANFIS and RBFN – Coactive Neuro Fuzzy Modeling, Framework Neuron Functions for Adaptive Networks – Neuro Fuzzy Spectrum.

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UNITV

APPLICATIONS OF COMPUTATIONAL INTELLIGENCE: Printed Character Recognition, Inverse Kinematics Problems, Automobile Fuel Efficiency Prediction, Soft Computing for Color Recipe Prediction.

Course Outcomes (COs): At the end of the course, student will be able to

CO	Course Outcomes	Knowledge Level (K)#
CO1	Able to apply fuzzy logic and reasoning to handle uncertainty in engineering problems.	**K2**
CO2	Make use of genetic algorithms to combinatorial optimization problems	**K3**
CO3	Apply artificial intelligence techniques, including search heuristics, knowledge representation, planning and reasoning.	**K5**
CO4	Learn and apply the principles of self-adopting and self-organizing neuro fuzzy inference systems	**K4**
CO5	Evaluate and compare solutions by various soft computing approaches for a given problem	**K3**

TEXT BOOKS:

1. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004.
2. N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2006.

REFERENCES:

1. Elaine Rich & Kevin Knight, Artificial Intelligence, Second Edition, Tata Mcgraw Hill Publishing Comp., 2006, New Delhi.
2. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, 1997.
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
4. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI,
5. R.Eberhart, P.Simpson and R.Dobbins, "Computational Intelligence - PC Tools", AP Professional, Boston, 1996.
6. Amit Konar, "Artificial Intelligence and Soft Computing Behaviour and Cognitive model of the human brain", CRC Press, 2008

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		2	**0**	**0**	**0**
ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE					

Objectives:

- To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
- The course aim of the importing basic principle of third process reasoning and inference sustainability is at the course of Indian traditional knowledge system
- To understand the legal framework and traditional knowledge and biological diversity act 2002 and geographical indication act 2003.
- The courses focus on traditional knowledge and intellectual property mechanism of traditional knowledge and protection.
- To know the student traditional knowledge in different sector.

Unit-I:
Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics,scope and importance, kinds of traditional knowledge, the physical and social contexts in whichtraditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge.

Unit-II:
Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

Unit-III:
Legal framework and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001(PPVFR Act); B:The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indications act 2003.

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Unit-IV:
Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

Unit-V:
Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Course Outcomes: After completion of the course, students will be able to:
1. Understand the concept of Traditional knowledge and its importance
2. Know the need and importance of protecting traditional knowledge
3. Know the various enactments related to the protection of traditional knowledge.
4. Understand the concepts of Intellectual property to protect the traditional knowledge

Reference Books:
1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012.
3. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002
4. Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino

E-Resources:
1. https://www.youtube.com/watch?v=LZP1StpYEPM
2.http://nptel.ac.in/courses/121106003/

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III Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**0**	**1.5**
Summer Internship 2 Months (Mandatory) after second year (to be evaluated during V semester)					

SUMMER INTERNSHIP EVALUATION

Learning Objectives:
The main objective of the internship is to gain up-to-date, practical experience in the real-working situation, in contrast to information gained during studies concerning mainly theoretical background of petroleum engineering.

The students are guided (through the Industry representative) to learn the following aspects:

- Application of the engineering skills, learned in class room, in real world.
- Working as a team to deliver the results along with senior engineering professionals, technicians, managers etc.
- Working safely in industrial environment.
- Result oriented approach in field operation, troubleshooting and engineering work.
- Present and / or report the work / project outcomes to various disciplines, departments & interest groups with confidence.
- To give a clear, organized and accurate oral presentation of Summer Training/Internship Report.
- To provide verbally/ through power point presentation of condensed large amounts of technical information into concise, condensed analysis.
- Sharing the practical knowledge obtained during training with fellow students.

Every Student should undergo summer training (summer internship program) in a petroleum industry (like ONGC)/service providing industry (like Halliburton) for 6-8 weeks and submit a report.

A summer internship report is a documentation of a student's work—a record of the original work done by the student in the summer internship of 6-8 week duration at the end of the IV semester.

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Summer Internship of the students shall be evaluated for 50 marks (1.5- credits) for weightage of 50% - Report and 50% - oral presentation by a committee constituted by the Head of the Department along with an industry expert or a faculty from other departments.

Outcomes:

The students are able to:

- Work safely in industrial environment.
- Work with various interest groups, disciplines, professionals, managers and technicians etc.
- Polish the engineering skills by applying the practical knowledge in day-to-day operations, trouble-shooting and minor-modifications.
- Build relations between university and industry that helps mutual collaboration and cooperation over long-term.
- Develop/strengthen the basic skills of interviewing, analysis, report writing, communication, decision-making, and problem solving.
- Assess the good practices of petroleum operations.
- Acquire good clarity in the technical topics being presented.
- Develop good communication skills.
- Practice the behaviors of effective speakers.
- Assess strengths in speaking and set goals for future growth.

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III Year - I Semester		**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
HONORS/MINOR COURSES					

Learning Objectives:
The students are able to:

- Avail the expertise in a specific subject from nation-wide reputed faculty, through MOOC (Massive Open Online Course)/ equivalent department course.
- Enhance knowledge in core subjects.
- Obtain knowledge in inter-disciplinary and job orientated minor courses.
- Acquire the skills for life-long learning.
- Diversify ones understanding of a topic useful to profession.

The departmental courses should be offered in lieu of MOOCS courses in case they are not available in NPTEL/SWAYAM. It is required for the students to do, a minimum of 7 courses to obtain the Honors/Minor degree. To fulfill the criteria of qualifying for Honors/minor degree, additional 20 credits are required.

The list of MOOCS/departmental courses in petroleum engineering is given in Appendix-I to do honors and Appendix-II shows the courses for minor degree in petroleum engineering. To obtain the minor degree for petroleum students the eligible students has to do the courses in any one discipline other than Petroleum Engineering.

The **20 credits** for honors or minor degree should be obtained from the fourth semester to the end of eighth semester. A candidate can take a 4-credit course in each semester during the above-mentioned period. It may be noted that, each eligible student has to get minimum of 8.0 SGPA without any backlogs in each semester to do honors/minor degree.

The eligible student shall register for the course **(Minimum of 12 weeks)** in the SWAYAM/NPTEL portal, offered through online with the approval of Head of the Department, under the guidance and supervision of a mentor/faculty. The student has to earn and submit a certificate by passing the exam conducted by SWAYAM/NPTEL for each course to obtain the required credits. If the student does not pass the subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered either through SWAYAM/NPTEL or department offered course in the next semester with the recommendation of mentor/faculty, approved by Head of the Department and shall pass in the examination. In case, of

departmental courses also the eligible student should pass the examination in each subject conducted by the department to obtain the certificate.

Outcomes:

The students will be able to:

- Overcome the digital divide in acquiring knowledge skills in fast developing technologies and be a part of digital revolution.
- Become a part of National Resource Pool to contribute the subject specific expertise.
- Assess the academic / professional priorities for future development.
- Develop self-learning skills with open-ended problems, case studies for life-long learning.
- Develop additional knowledge skills in core and inter-disciplinary courses.
- Orient themselves with the learning methodologies outlined in the new educational policy of India.

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SEM VI (THIRD YEAR)

III Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
PETROLEUM PRODUCTION ENGINEERING					

Learning Objectives:
The students will be able to learn:

- The fundamental concepts in petroleum production engineering.
- The concepts and calculations of reservoir deliverability, wellbore performance and choke performance.
- The concepts and calculations for well deliverability, nodal analysis, forecast performance, and production decline analysis.
- The theory, design and operation of equipment in various artificial lift techniques.
- The various methods of well stimulation.

UNIT-I
Petroleum Production System: Overall view, production from various types of reservoir based on drive mechanisms, field development method, safety control system.
Properties of Oil and Natural Gas: Solution gas-oil ratio, density of oil and gas, viscosity of oil and gas, formation volume factor of oil and gas, oil and gas compressibility, specific gravity of gas and gas pseudo critical pressure and temperature.

UNIT-II
Reservoir Deliverability: Flow regimes - transient, steady state, pseudo steady state, PTA, IPR for various types of wells.
Well bore Performance: Single & multiphase liquid flow in oil wells, single phase & mist flow in gas wells.
Choke Performance: Sonic & subsonic flow, single & multiphase flow in oil & gas wells.

UNIT-III
Well Deliverability: Nodal analysis with bottom-hole node, well head node and choke node for oil and gas wells.
Forecast of Well Production: Oil and gas production during transient flow period and pseudo transient period.
Production Decline Analysis: Exponential, harmonic and hyperbolic decline methods-model identification-determination of model parameters.
Safety Protocols and risk analysis: Principles and methods.

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UNIT-IV

Artificial Lift Methods: Sucker rod pumping system- selection of unit and types of unit, Load & power requirements, performance analysis; electrical submersible pumps: principle, design & operation; gas lift system: types, evaluation of potential compression requirements, study of flow characteristics, principles of compression, types of compressors, selection of gas lift valves, types of valves, principles of valve operation, setting & testing.

UNIT-V

Well Stimulation: Well problem identification; matrix acidizing- design for sandstone & carbonate reservoirs, hydraulic fracturing – formation fracture pressure, geometry, productivity of fractured wells, hydro-fracture design, selection of fracturing fluid, propant, post frac evaluation.

Outcomes:

The students are able to:

- Apply the concepts in petroleum production engineering.
- Perform the calculations on reservoir deliverability, wellbore performance and choke performance.
- Perform the calculations for well deliverability, nodal analysis, forecast performance, and production decline analysis.
- Assess and design various artificial lift systems.
- Design and execute matrix acidizing and hydro-fracturing operations.

Text Books:

1. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2007.
2. Petroleum Production Systems, M. J. Economides, A. Daniel Hill & C. E. Economides, Prentice Hall, 1994.

Reference Books:

1. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
2. The Technology of Artificial Lift Method, Vol. 1, Brown E., Pennwell Books, 1977.

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III Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
PETROLEUM RESERVOIR ENGINEERING-II					

Learning Objectives:
The students will be able to learn:

- The application of diffusivity equation for oil and gas well testing.
- The evaluation of reservoir parameters like permeability and skin factor etc. for oil and gas wells.
- The procedures for deliverability tests for gas wells, interference & pulse tests and type curves and history matching.
- The basics of gas and water coning.
- The various methods to predict water influx.
- The theory of immiscible fluid displacement and its application to water flooding and gas flooding.

UNIT – I
The constant terminal rate solution of the radial diffusivity equation and its application to oil well testing: The constant terminal rate solution – Transient, semi steady state and steady state flow conditions – Dimensionless variables – General theory of well testing – The Mathews, Brons, Hazebroek pressure build up theory - Pressure build up and drawdown analysis techniques for oil well testing – Multi Rate testing – The effects of partial well completion – After flow analysis.

UNIT– II
Gas well testing I: Linearization and solution of the basic differential equation for the radial flow of a real gas – The Russel, Goodrich et. al. Solution technique – The Al Hussainy, Ramey Craw-ford solution techniques – Non-Darcy flow – Determination of the non- Darcy coefficient F - The constant terminal rate solution for the flow of a real gas – General theory of gas well testing – Use of pseudo pressure in gas well test analysis.

UNIT– III
Gas well testing II: Drawdown and pressure build up tests for gas wells- Multi rate testing of gas wells.
Other tests for oil and gas wells: Analysis of well tests using type curves- Interference and Pulse Tests - Flow after flow tests in gas wells- Isochronal & modified isochronal tests for gas wells - Injection Well Testing.

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UNIT– IV

Gas and water coning: Basic Concepts in Coning, Coning in vertical and horizontal wells, Critical rate and Breakthrough time calculations from various correlations- After breakthrough time calculations.

Natural water influx: Steady state water influx methods- Unsteady state water influx theory of Hurst and Van Everdingen and its application in history matching – The approximate water influx theory of Fetkovich for finite aquifers and predicting the amount of water influx – Application of influx calculation techniques to steam soaking.

UNIT– V

Immiscible Fluid displacement: Basic concept -Physical assumptions and their implication – The fractional flow equation – Buckley-Leverette one dimensional displacement – The Welge method- Oil recovery calculations – Displacement under segregated flow conditions – Allowance for the effect of finite capillary transition zone in displacement calculations – Displacement in stratified reservoir – Water flooding – water flood patterns- Water flood design – Gas Flooding – Gas flood design.

Outcomes:

The students will be able to:

- Apply the diffusivity equation for oil and gas well testing.
- Use the oil and gas well testing data from build up as well as drawdown for interpretation to obtain reservoir parameters.
- Carry out the interpretation of different deliverability tests for gas wells.
- Interpret the impulse and interference test data
- Use type curves for history matching.
- Predict the water influx by using different methods.
- Estimate the critical flow rates for water and gas coning
- Apply the concepts of immiscible fluid displacement in water and gas floods.

Text Books:

1. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17thImpression 1998).
2. Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing, 2006.
3. B. C. Craft – M. Hawkins, Ronald E. Terry & J. Brandon Rogers, 3rd revised Edition, Prentice Hall, New York, 2014.

Reference Books:

1. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham &Trotman Inc. 1986.
2. Basic Reservoir Engineering, Rene Cosse, Editions Technip, 1993.
3. Petroleum Reservoir Engineering, James W Amyx, Daniel M. Bass Jr., Robert L. Whiting, McGraw Hill, 1960.

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		3	**0**	**0**	**3**
PETROLEUM REFINERY & PETROCHEMICAL ENGINEERING					

Learning Objectives:
The students will be able to learn:

- The properties and their significance of crude oils and petroleum fractions.
- The details of the various petroleum refinery processes including primary, secondary and supporting processes.
- The various aspects of environmental pollution, its control and waste disposal methods.
- The various feed-stocks for the production of petrochemicals.
- The process technologies for the various petrochemical products.

UNIT-I
Introduction: Overall refinery operations –Structure of a Refinery - World and Indian scenario in refining.
Refinery feed stocks: Crude oil classification - composition and properties – evaluation of crude oils.
Petroleum Products and their specifications: LPG – gasoline - diesel fuels - jet and turbine fuels – lube oils - heating oils – residual fuel oils - wax and asphalt-petroleum coke - all product specifications - product blending.

UNIT-II
Crude distillation: Atmospheric and vacuum distillation units, auxiliary equipment such as desalters, pipe-still heaters and heat exchanger trains etc.
Catalytic reforming and isomerization: Catalytic reforming processes (for petroleum and petrochemical feed stocks) – isomerization processes - feed stocks - feed preparation – process variables - yields.

UNIT-III
Thermal, Catalytic cracking, HydroCracking processes: Visbreaking- delayed coking – fluid catalytic cracking - feed stocks –catalysts - process description and effect of process variables – Hydrocracking: feed stocks process description and effect of process variables.
Hydro treating & Hydro processing: Naphtha, kerosene, diesel, VGO & resid, hydro treating / hydro processing–catalysts – process description and effect of process variables.

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UNIT-IV

Environmental issues in petroleum refining: Pollution in petroleum processes and operations-control, and disposal methods.

Petrochemical Industry: – Indian petrochemical industry- feed stocks – process description and process variables - naphtha cracking-gas cracking and gas reforming.

UNIT-V

Chemicals from gas reforming: Methanol- acetic acid- ammonia and urea.

Chemicals from ethylene: Ethylene oxide-monoethylene glycol - ethyl benzene-styrene.

Polymers: LDPE, HDPE & LLDPE and polypropylene – PVC - polystyrene.

Outcomes:

The students are able to:

- Assess the scenario of world and Indian petroleum refining.
- Estimate the quantities of various petroleum products obtained from various types of crude oil processing.
- Analyze and design the various petroleum refinery processes including primary, secondary, treatment and supporting processes.
- Assess the various aspects of environmental pollution to design the control and waste disposal methods.
- Assess various petroleum feed stocks for the production of ethylene, propylene, butylene and butadiene etc.
- Design the processes and equipment for various petrochemical products.

Text Books:

1. Petroleum Refining: Technology and Economics, J.H. Gary and G. E. Handwerk, 4thEdition, Marcel Dekkar, Inc., 2001.
2. Elements of Petroleum Processing, D S Jones, Wiley 1995.
3. Petrochemical Process Technology, ID Mall, Macmillan India Ltd., 2007.

Reference Books:

1. Petroleum Refining Engineering, WL Nelson, 4thEdition, McGraw Hill Company, 1958.
2. Chemical Technology of Petroleum, W. S. Gruese and D.R. Stevens, McGraw Hill, 1960.
3. Fundamentals of Petroleum Chemical Technology, P Belov, Mir Publishers, 1970.

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4. Petrochemical Processes, A. Chauvel and G.Lefebvre, Volume 1 & 2, Gulf Publishing Company, 1989.
5. Chemistry of Petrochemical Processes, Sami Mater, Lewis F. Hatch, 2nd Edition, Gulf Professional Publishing, 2001.
6. Chemicals from Petroleum: An Introductory Survey, Waddams, A.L., 4th Edition, Gulf Publishing, 1978.
7. Handbook of Petrochemicals Production Processes, R.A. Meyers, TRW,Inc., 2005.
8. Petrochemical Processes Handbook, Hydrocarbon Processing, 2010.

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		3	**0**	**0**	**3**
ADVANCED WELL COMPLETION ENGINEERING (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The application of basic concepts of well reservoir engineering in well completions.
- The details of various types of well completions and factors affecting well completions.
- The material selection criteria and stress analysis in the system design.
- The selection criteria and details of the well completion equipment.
- The methods for installing well completion equipment for the onshore and offshore wells.
- Fundamental of well completion techniques and installation system.

UNIT-I
Basics of well reservoir engineering in well completions: IPR, perforation, well stimulation techniques including fracturing. Sand controls- introduction- rock strength analysis- sand control prediction and mitigation techniques including installation of screens, gravel pack job and sand consolidation methods.

UNIT-II
Well completion life: Introduction- types of well completion- factors affecting well completion-TPR- flow through tubing, well completion fluid properties and production and injection tubing sizing analysis.

UNIT-III
Material selection and stress analysis: Selection of control lines for Injection of corrosion inhibitors, scale inhibitors and use of other seals. Load and stress analysis of tubing including burst pressure, collapse, axial load calculation and some design factors.

UNIT-IV
Well completion equipment: Introduction- types of completion equipment- surface and subsurface equipment. Rating of SSSV, packer, landing nipple locks and sling sleeve and side pocket mandrel selection. Selection of control lines and subsea isolation valve.

UNIT-V

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Well completion installation system: Introduction-onshore and subsea well completion installation system. Well bore cleanup operations-well fluid displacement. Filtration prior to well flow

Outcomes:

The students are able to:

- Apply the basic concepts of well reservoir engineering in well completions.
- Screen the various types of well completions.
- Analyze the factors affecting well completions.
- Select the suitable materials of construction for well completion equipment.
- Carry out the stress analysis for the system design like tube design.
- Install the well completion equipment for onshore and offshore wells.

Text Books:

1. Advanced Well Completion Engineering, Wan Renpu, Gulf Professional Publishing, 2011.
2. Well Completion Design, Jonathan Bellarby, Elsevier, 2009.

Reference Books:

1. Well Completion and Servicing, D. Perrin, Micheal Caron, Georges Gaillot, Editions Technip, 1999.
2. Primer of Well Service, Workover and Completion, Petroleum Extension Service
(PETEX), University of Texas at Austin, 1997.
3. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman, Inc., 1986.

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		3	**0**	**0**	**3**
APPLIED MATHEMATICS IN RESERVOIR ENGINEERING (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The Application of Linear, Non-linear curve fitting and Numerical Integration and Convergence techniques.
- The concepts of numerical Methods for Reservoir Simulation.
- The applications of the diffusivity equation.
- The application of Bessel functions, Fourier transforms and Green's functions.
- The application of Convolution integral in reservoir engineering and probabilistic distribution function for reserve estimation.
- The application of mathematical methods in Modelling of Fluid Flow in Oil reservoir.

UNIT-I

Application of Linear, Non-linear curve fitting and Numerical Integration and Convergence techniques: Mathematical models for correlating PVT properties - Non-linear curve fitting for decline curve analysis in reserve estimation **-** Iterative Flash Algorithms - Application of Simpson´s and trapezoidal formulas for volume calculation of subsurface structures: Basis for numerical integration – Simpson Rule and Trapezoidal Rule - The application of numerical integration in the description of the hydrocarbon reservoir- Volume calculation in massive reservoir - Volume calculation in layered reservoir; Determination of Bottom-hole pressure for gas wells Using Trapezoidal Rule and Runge-Kutta methods with different convergence techniques - Iterative techniques for predicting cumulative oil and gas production.

UNIT - II

Numerical Methods for Reservoir Simulation: Introduction to FDM, FEM and FVM - Solving the discretised equations - Solving elliptic/parabolic problems - Integral formulation: Finite differences - Variational formulation: Finite elements - Saddle point formulation: Mixed finite elements - Solving hyperbolic/parabolic problems - Hyperbolic formulations - Eulerian formulation: Finite volumes - Lagrangian formulation: Characteristic methods.

UNIT-III

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Application of the diffusivity equation: One dimensional and three dimensional cases – Dimensionless forms – Radial problem – Super position – Using super position to handle boundary conditions – Applications in Darcy's flow – Continuity equation - Diffusivity equations for steady state, pseudo steady state flow – Stabilized flow conditions – Linear source solutions – Application of dimensionless form equations (Laplace form) - Diffusivity equations for buildup and drawdown tests of oil and gas wells.

UNIT - IV

Application of Bessel functions, Fourier transforms and Green's functions: Bessel and modified Bessel equations – Laplace space solution for P_D - Late Time Behavior of P_D - Finite Well Radius Solution: Early Time Behavior of P_D and Late Time Behavior of P_D; Constant Pressure Inner Boundary Condition: Early Time Behavior of the Flow Rates; Application to van Everdingen method for water influx; Application of Fourier transformations and Greens functions.

UNIT - V

Application of Convolution integral in reservoir engineering: Generalized convolution - Fractional diffusivity equation - unsteady state water influx equations.

Application of probabilistic distribution function: Generation of final probabilistic distribution function for each input parameter with the help of Monte Carlo Simulation to estimate the reserves.

Application Mathematical Methods in Modelling of Fluid Flow in Oil Reservoir: Finite difference method, Finite element method, Vortex element method and Monte Carlo method**.**

Outcomes:

The students are able to:

- Apply the application of Linear, Non-linear curve fitting and Numerical Integration and Convergence techniques.
- Assess the different concepts of numerical Methods for Reservoir Simulation.
- Numerically solve the diffusivity equation.
- Use Bessel functions, Fourier transforms and Green's functions.
- Apply the Convolution integral in reservoir engineering, probabilistic distribution function in reserve estimation and numerical analysis in Modelling of Fluid Flow in Oil reservoir.

Text books:

1. Applied mathematics in reservoir engineering, Rosalind Archer Standard University, spring, 2000.

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2. Elementary Numerical Analysis: An Algorithmic Approach, S.D. Conte & C. de Boor, Third edition, McGraw-Hill, 1981.
3. Mathematics of Reservoir Simulation, Richard E. Ewing, Society for Industrial and Applied Mathematics (SIAM), 1983.

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		3	**0**	**0**	**3**
NATURAL GAS HYDRATES (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The overview of NGH and classification of NGH.
- The different physical and chemical properties of NGH.
- The hydrate formation by using different methods.
- The exhibiting hydrate formation and dehydration processes.
- The deactivating the hydrates using heat and pressure**.**
- The conversion, flow assurance, storage and transportation of natural gas hydrates.

UNIT-I:
Introduction: Overview of natural gas hydrates- Natural gas- Water molecule- Hydrates- Water and natural gas- Free-Water- Heavy water- Units.
Hydrate types and formers: Type I hydrates- Type II hydrates- Size of the guest molecule- n-Butane- Other hydrocarbons and non-hydrocarbon molecules- Chemical properties of potential guests- Liquid hydrate formers- Type H hydrates- Hydrate forming conditions- Pressure-Temperature- Composition- Other hydrate formers- Mixtures- Examples.

UNIT-II:
Physical properties of hydrates: Molar mass - Density- Enthalpy of fusion- Heat capacity- Thermal conductivity- Mechanical properties- Volume of gas in hydrate- Ice versus hydrate- Examples.
Water content of natural gas: Equilibrium with liquid water- Equilibrium with solids- Examples.

UNIT-III:
Hydrate formation hand calculation methods: Gas gravity method- K-Factor method- Baillie-Wichert method- Comments on these methods- Examples.
Hydrate formation computer methods: Phase equilibrium calulations - Van der Waals and Platteeuw- Parrish and Prausnitz-Ng and Robinson methods-Commercial software packages- Accuracy of these programs- Dehydration- Examples.

UNIT-IV:

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Inhibiting hydrate formation with chemicals: Freezing point depression- Hammer-Schmidt equation- Nielsen-Bucklin equation- New method- Brine solutions- Advanced calculation methods- Inhibitor vaporization- Comment on injection rates- Kinetic inhibitors- Examples.

Dehydration of natural gas: Water content specification-Glycol dehydration- Molecular sieves- Refrigeration- Examples.

UNIT-V:

Combating hydrates using heat and pressure: Use of heat- Heat loss from a buried pipeline- Line heater deign- Two-Phase heater transfer- Depressurization- Melting a plug with heat- Examples.

Special problems: Gas hydrate conversion technology to natural gas – flow assurance methods - natural gas storage and transportation as gas hydrates.

Outcomes:

The students are able to:

- Have good knowledge in dealing with NGH.
- Have knowledge of different equilibriums of liquid water and solids with natural gas.
- Model different forms of hydrate formation using both hand calculations and computer methods.
- Understand the different properties and challenges of NGH.
- Design line heaters for effective transportation.
- Have good knowledge of conversion, flow assurance and applications of gas hydrates.

Text Books:

1. Natural Gas Hydrates: A Guide for Engineers, John J. Carroll, Gulf Professional Publishers, 2003.
2. Clathrate Hydrates of Natural Gases, E. Dendy Sloan, Jr., C. Koh, 3rdEdition, CRC Press, 2007.

Reference Book:

1. Natural Gas Hydrates in Flow Assurance, E. Dendy Sloan, C. Koh, A. K. Sum, A. L. Ballard, J. Creek, M. Eaton, N. McMullen, T. Palermo, G. Shoup and L. Talley, Elsevier, 2010.

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		3	**0**	**0**	**3**
BASIC CONCEPTS IN PETROLEUM DRILLING AND COMPLETIONS (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The concepts of drilling geology, oil and gas generation, migration and reservoirs.
- The planning and drilling a development well on land and offshore.
- The rig selection, rig equipment and drill bits.
- The concepts of drilling fluids, directional and horizontal drilling.
- The process of well completions.

UNIT-I
Overview of Drilling: Drilling geology, Igneous, metamorphic, and sedimentary rocks, Plate tectonics-Lithology-rocks strength and stresses-hydrostatic pressure imposed by a fluid.
Oil and Gas Generation, Migration and Reservoirs: Source rock and hydrocarbon generation, vital rock properties, primary migration, structural trap, Reservoir rock, seal rock, secondary migration, reservoir drives.

UNIT-II
Planning and Drilling a Development Well on Land: Identifying a prospect-well proposal-gathering data-designing the well-writing the well program-drilling the well- production testing the well-abandoning the well– estimation of formation pressures.
Planning and Drilling a Development Well Offshore: Well planning-hole and casing sizes-writing the well program-drilling the well.

UNIT III
Rig Selection and Rig Equipment: Selecting a suitable drilling rig- classifications of drilling rigs-rig systems and equipment.
Drill Bits: Roller cone bits-fixed cutter bits-core bits-optimizing drilling parameters-grading the dull bit-bit selection-drill bit economics.

UNIT IV
Drilling Fluids: Functions of drilling fluids-basic mud classifications-designing the drilling fluid.
Directional and Horizontal Drilling: Why drill directional wells?-tools and techniques for kicking off the well-controlling the well path of deviated well-

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horizontal wells-multilateral wells-surveying-navigation by reference to reservoir characteristics.

UNIT-V

Well Completion: Types of wells- types of completion - Perforation methods.

Packers: Function – Application.

Completion equipment: (SSD, SSSV, mandrels, locks etc.)-Christmas tree–Subsea well completions, permanent gauges - memory gauges - intelligent completion equipment - Tubing string design.

Outcomes:

The students are able to:

- Apply the concepts of drilling geology, oil and gas generation, migration and reservoirs.
- Assess the planning and drilling a development well on land and offshore.
- Analyze the rig selection, rig equipment and drill bits.
- Apply the concepts of drilling fluids, directional and horizontal drilling.
- Assess the process of well completions.

Text Books:

1. Drilling Technology in non-technical knowledge, Steve Devereux, CEng, Pennwell Books, 1999.
2. Well Completion and Servicing, D. Perrin, Micheal Caron, Georges Gaillot, Editions Technip, 1999.

Reference Books:

1. Drilling equipment and operations, William lyons, 1st edition Gulf Publications, 2010.
2. Drilling Engineering, J.J. Azar and G. Robello Samuel, Pennwell Books, 2007.
3. Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman, 1985.
4. Drilling Engineering: A Complete Well Planning Approach, Neal Adams, Tommie Charrier Pennwell, 1985.
5. Practical Well Planning and Drilling Manual, Steve Devereux, Pennwell, 1998.
6. Formulas and Calculation for Drilling, Production and Workover, Norton J. Lapeyrouse, 2nd Edition, Gulf Publishing, 2002.
7. Well Engineering and Construction, Hussain Rabia, Entrac Consulting, 2002.
8. Well Completion Design, Jonathan Bellarby, Elsevier, 2009.

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BASIC CONCEPTS IN PETROLEUM PRODUCTION ENGINEERING (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The properties of oil and natural gas, fundamental concepts in petroleum production engineering.
- The concepts on reservoir deliverability, well bore performance and Nodal analysis.
- The basic concepts on artificial lift techniques.
- The Well problem identification and Matrix acidizing techniques.
- The concept of Hydraulic fracturing.

UNIT-I
Petroleum production system overall view: Production from various types of reservoir based on drive mechanisms, field development method, Safety control system.
Properties of oil and natural gas: Solution Gas-oil ratio, density of oil and gas, viscosity of oil and gas, formation volume factor of oil and gas, oil and gas compressibility, specific gravity of gas and gas pseudo critical pressure and temperature.

UNIT-II
Reservoir Deliverability: Flow regimes - transient, steady state, pseudo steady state IPR for various types of wells.
Well bore performance: Single & multiphase liquid flow in oil wells, single phase & mist flow in gas wells, Choke performance-basic concepts.
Nodal Analysis: Analysis with the bottom-hole node, Analysis with wellhead node, deliverability of multilateral well.

UNIT-III
Basic concepts on artificial lift methods: Sucker rod pumping system, electrical submersible pumps and Gas lift system.

UNIT-IV

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Production Stimulation: Well problem identification, basic concepts in Matrix acidizing: Acid-Rock interaction, sandstone acidizing design and carbonate acidizing design.

UNIT-V:

Hydraulic fracturing: Formation fracturing pressure, Fracture geometry, Productivity of fractured wells, Basic concepts in hydraulic fracturing design, and Post-Frac evaluation.

Course outcomes:

The students are able to:

- Assess the properties of oil and natural gas, fundamental concepts in petroleum production engineering.
- Apply the concepts on reservoir deliverability, well bore performance and Nodal analysis.
- Assess the basic concepts on artificial lift techniques.
- Assess the Well problem identification and Matrix acidizing techniques.
- Obtain knowledge on Hydraulic fracturing**.**

Text Books:

1. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2007.
2. Petroleum Production Systems, M. J. Economides, A. Daniel Hill & C. E. Economides, Prentice Hall, 1994.

Reference Books:

1. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
2. The Technology of Artificial Lift Method, Vol. 1, Brown E., Pennwell Books, 1977.

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III Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
BASIC CONCEPTS IN PETROLEUM RESERVIOR ENGINEERING (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The fundamentals in reservoir engineering.
- The concepts of pressure regimes, fluid contacts, flow regimes and Darcy's law.
- The concepts of resources and reserves.
- The concept of volumetric reserves estimation.
- The basic concept of material balance applied to oil and gas reservoirs.
- The concepts of decline curve analysis.

UNIT- I
Fundamentals in Reservoir Engineering: Definition of a Reservoir - Elements Required in the Definition of a Reservoir - Drainage and Imbibition Process - Drainage/Desaturation Process - Imbibition/Resaturation Process - Reservoir Engineering - Role or Job Description of Reservoir Engineers - Types of Reservoir - Phase Envelope - Oil Reservoirs - Types of Reservoir Fluids - Types of Fluids in Terms of Flow Regime and Reservoir - Reservoir Geometry - - Oil Viscosity Behavior - Oil Formation Volume Factor - Skin - Application of Dimensionless Parameters in Calculating Flow Rate and Bottom Flowing Pressure-

UNIT -II
Pressure Regimes and Fluid Contacts: Pressure Regime of Different Fluids Some Causes of Abnormal Pressure - Fluid Contacts - Methods of Determining Initial Fluid Contacts - Estimation of the Average Pressure from Several Wells in a Reservoir.
Flow Regimes and Darcy's Law:
Flow Regimes - Unsteady or Transient-State Flow – Steady state Flow – Pseudo-Steady State Flow - Darcy's Law- Deliverability equations for different flow regimes- Productivity Index (PI or J) - Factors Affecting the Productivity Index - phase Behavior in Petroleum Reservoirs - Relative Permeability Behavior.

UNIT- III
Resources and Reserves: Parties that Use Oil and Gas Reserves - Reasons for Estimating Reserves - Resources and Reserves - Hydrocarbon Resources - Hydrocarbon Reserves - Identification of Uncertainty in Reserves Estimation - Uncertainty in Geologic data - uncertainty in Seismic Predictions - Uncertainty in Volumetric Estimate -Economic Significance of Reservoir Uncertainty - Reservoir Characterization.

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Volumetric Reserves Estimation: Overview of Reserve Estimation - Volumetric Method - Errors in Volumetric Method - Application of Volumetric Method - Sources of the Volumetric Input Data - Calculation of Reservoir Bulk Volume - What is a Contour - Methods of Contouring - Deterministic Versus Probabilistic Volumetric Reserves Estimation.

UNIT- IV

Material Balance : Assumptions of Material Balance Equation - Limitations of Material Balance Equation - Data Requirement in Performing Material Balance Equation - Production Data - PVT Properties - Reservoir Properties - Other Terms - Sources of Data Use for the MBE - Uses of Material Balance Equation - PVT Input Calculation Various Correlations - Derivation of Material Balance Equations: Gas Reservoir Material Balance Equation - Oil Material Balance Equation - Reservoir Drive Mechanisms - Basic Data Required to Determine Reservoir Drive - Mechanism Solution Gas (Depletion) Drive - Gas Cap Expansion (Segregation) Drive - Water Drive Mechanism - Rock Compressibility and Connate Water Expansion Drive - Gravity Drainage Reservoirs - Combination Drive Reservoirs - Representation of Material Balance Equation under Different Reservoir Types – Linear forms of Material Balance Equations.

UNIT -V

Decline Curve Analysis : Application of Decline Curves - Causes of Production Decline - Reservoir Factors that Affect the Decline Rate- Operating Conditions that Influence the Decline Rate - Types of Decline Curves - Identification of Exponential Decline - Identification of Harmonic Decline - Identification of Hyperbolic Decline - Mathematical Expressions for the Various Types Exponential (Constant Percent) Decline - Harmonic Decline Rate - Hyperbolic Decline rate.

Outcomes:

The students are able to:

- Apply the basic concepts in petroleum reservoir engineering.
- Implement the concepts of pressure regimes, fluid contacts, flow regimes and Darcy's law for reservoir deliverability.
- Assess the resources and reserves.
- Estimate the reserves by volumetric methods.
- Apply the material balance equation to estimate oil and gas reserves.
- Apply decline curve analysis to estimate the reserves.

Text Book:

1. Reservoir Engineering: Fundamentals and Applications, Sylvester_Okotie and Bibobra Ikporo, Springer, 2019.

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Reference Books:

3. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17th Impression 1998).
4. B. C. Craft – M. Hawkins Applied Petroleum Reservoir Engineering, Third Edition, Revised by Ronald E. Terry & J. Brandon Rogers, Prentice Hall, New York, 2014.

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		0	**0**	**3**	**1.5**
PETROLEUM ANALYSIS LABORATORY					

Learning Objectives:

The students will be able to learn:

- The analysis of crude oil and its products.
- The tests for various properties of crude oils and their products.
- The generation of distillation characteristics (ASTM curves) of crude oil, diesel, gasoline and kerosene.
- The determination of water content in different petroleum products.
- The corrosiveness of petroleum products on materials.

List of experiments:

1. Determination of Distillation characteristics of Gasoline / Diesel / Kerosene.
2. Determination of Reid Vapor Pressure of Crude oil / Gasoline.
3. Determination of Viscosity of Diesel and lubricating oils.
4. Determination of Smoke Point of Kerosene.
5. Determination of Carbon Residue of petroleum products.
6. Determination of Flash & Fire points of gasoline, kerosene and other products.
7. Estimation of water content in petroleum products.
8. Estimation of calorific value of solid, liquid and gaseous fuels.
9. Determination of Aniline point of Gasoline and Diesel oil.
10. Determination of Cloud & Pour Points of petroleum products.
11. Detection of Corrosiveness of petroleum products

Outcomes:

The students are able to:

- Use the analysis of crude oil and its products in the design of refinery operations.
- Generate distillation characteristics (ASTM curves) of crude oil, diesel, gasoline and kerosene for designing primary distillation columns.
- Assess the limits of water content in different petroleum products while meeting the specifications.
- Screen and select the appropriate material of construction for refinery process units.

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		0	**0**	**3**	**1.5**
PETROLEUM EQUIPMENT DESIGN & SIMULATION – LABORATORY					

Learning Objectives:
The students will be able to learn:

- The concepts of design and simulation of various equipment used in petroleum industry.

The following numerical experiments have to be simulated using C/C++/Simulink using MATLAB/UNISIM for obtaining design and simulation (repeated simulations provide the design of equipment):

1. Oil- Water separator.
2. Gas- Oil-Water separator.
3. Lean / rich amine heat exchanger.
4. Air cooled heat exchanger.
5. CO_2 and H_2S absorber unit using, MEA/DEA amine solution.
6. Stripping unit.
7. Single stage flash vaporization unit.
8. Three stage flash vaporization unit.
9. Liquid pumping system & simulation of water-hammer phenomena.
10. Gas Compressor unit.
11. Flash and differential liberation tests.

Outcomes:
The students are able to:

- Design and simulate the two-phase and three phase separators.
- Design and simulate compressors and flash vaporization units.
- Design and simulate absorber-stripper unit for removal of CO_2 and H_2S from natural gas.
- Size /rate the pipeline & pumping systems.
- Do thermal sizing or rating of shell & tube exchangers as per TEMA specifications and API guidelines.
- Generate sized equipment data sheets as per the industry standards with required information for detailed design / manufacture.

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III Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
PETROLEUM RESERVOIR SIMULATION – LABORATORY					

Learning Objectives:
The students will be able to learn:

- The simulation of reservoirs for different production scenarios to find an optimal one before the reservoir is actually put on production.
- The reservoir simulation models for existing reservoirs to study production decline and production forecasts.
- The reservoir simulation models for new reservoirs to maximize recovery of oil and gas to make investment decisions.

Reservoir Simulation Experiments:
The students will be trained in the software Package ECLIPSE, COMSOL or any other equivalent software to model and solve reservoir engineering problems.

1. File organization and structure
2. Selection of suitable by grid sensitivity studies.
3. Screening Criteria
   i. Fluid properties
   ii. Rock properties
4. Well Pattern and Boundary Conditions
5. Aquifer modeling (single and multiphase fluid flow: Oil-Water/Oil-Water-Gas)
6. History matching consisting of adjusting the parameters of the model such as permeability and porosity until the computed results for the historical period are close to historical data
7. Prediction of properties including permeability, relative permeability, saturation etc.

Outcomes:
The students are able to:

- Simulate reservoirs for different production scenarios to find an optimal one before the reservoir is actually put on production.
- Carry out reservoir simulation with different models for existing reservoirs to study production decline and production forecasts.
- Carry out reservoir simulation with different models for new reservoirs to maximize recovery of oil and gas to make investment decisions.
- Present results of the simulation studies in a written report.

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III Year - II Semester		**L**	**T**	**P**	**C**
		1	**0**	**2**	**2**
DATA SCIENCE					

Learning Objectives:
The students will be able to learn:

- Provide you with the knowledge and expertise to become a proficient data scientist.
- Demonstrate an understanding of statistics and machine learning concepts that are vital for data science;
- Produce Python code to statistically analyse a dataset;
- Critically evaluate data visualizations based on their design and use for communicating stories from data

UNIT-I:
Introduction to Core Concepts and Technologies- Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.

UNIT-II:
Data Collection and Management- Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, using multiple data sources.

UNIT III:
Data Analysis- Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.

UNIT-IV:
Data Visualisation- Introduction, Types of data visualisation, Data for visualisation- Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.

UNIT-V:
Applications of Data Science- Technologies for visualisation, Bokeh (Python), recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.

Course Outcomes:

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CO	Course Outcomes	Knowledge Level (K)#
CO1	Acquire the knowledge and expertise to become a proficient data scientist	**K3**
CO2	Demonstrate an understanding of statistics and machine learning concepts that are vital for data science	**K3**
CO3	Explain how data is collected, managed and stored for data science	**K2**
CO4	Interpret the key concepts in data science, including their real-world applications and the toolkit used by data scientists	**K2**
CO5	Illustrate data collection and management scripts using MongoDB	**K3**

Text Books:

1. "The Art of Data Science", 1st edition, Roger D. Peng and Elizabeth matsui, Lean Publications, 2015
2. "Algorithms for Data Science", 1st edition, **Steele**, Brian, **Chandler**, John, **Reddy**, Swarna, springers Publications, 2016

Reference Books:

1. Doing Data Science: Straight Talk From The Frontline, 1st edition, Cathy O'Neil and Rachel Schutt, O'Reilly, 2013
2. Mining of Massive Datasets, 2nd edition, Jure Leskovek, Anand Rajaraman and Jeffrey Ullman, v2.1, Cambridge University Press, 2014

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		2	**0**	**0**	**0**
IPR&PATENTS					

Learning Objectives:

- To acquire detailed knowledge of IPR Laws and its relevance, application and practice in Engineering Discipline, the student has to know the increasingly assumed role of Intellectual Property globally with the rapid pace of technological and scientific innovations created by the human intellect and to understand the TRIPS Agreement and the functions WIPO, WTO to enhance the protection different IPRs and the enforcement of competition law to prevent unfair competition
- To acquire a comprehensive knowledge about Copyright as an exclusive right given by the law to the creators of literary, scientific, dramatic, musical and artistic works and producers of cinematography films and sound recordings, thereby protecting and rewarding creativity and ensure moral and economic rights of Authors of those creative works, which induces others to do the same is the basis for socio- economic development and progress of the society
- To acquire a comprehensive knowledge about Patent as an exclusive right granted for the inventions arising from the human intellect and its considerable commercial value of those scientific inventions having potential for industrial application are being protected for a limited duration to encourage the innovations.
- Study about Trade Marks Law gives an insight about Trade Mark as a statutory right provides protection to the owner of the mark by ensuring the exclusive right to use it, or to authorize another to use the same for consideration which will promote initiative and enterprise worldwide and hinders the efforts of unfair competitors. Trade Secrets and confidential information relating to the business enterprises and why this key strategic asset needs to be protected
- Study of Information Technology Act and Cyber Laws provide a detailed insight to regulate online and digital transactions and promoting E-governance, E-commerce, E-banking with required confidentiality, data security and to prevent cyber-crimes.

UNIT – I:

Introduction to Intellectual Property Rights (IPRs): Concept of Property - Introduction to IPR – IPR Tool Kit – International Instruments and IPR – WIPO - TRIPS – WTO – IPR Laws - IPR Protection and Regulation - Copyrights and Neighbouring Rights – Industrial Property – Patents – Designs - Traditional Knowledge – Geographical Indications - Emerging Areas of IPR.
Law of Unfair Competition – Competition Commission.

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UNIT – II:

Copyrights and Neighbouring Rights: Introduction to Copyrights – Principles of Copyright Protection – Law Relating to Copyrights - Subject Matters of Copyright – Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works – Rights of Distribution – Rights of Performers – Copyright Registration – Limitations – Infringement of Copyright – Case Law.

UNIT – III:

Patents: Introduction to Patents - Patent Laws in India – Patent Requirements – Product Patent and Process Patent - Patent Search - Registration and Grant of Patent – Exclusive and Monopoly Rights – Limitations - Ownership - Transfer — Revocation of Patent – Patent Appellate Board - Infringement of Patent – Double Patenting — Compulsory Licensing - Patent Cooperation Treaty – New developments - Software Protection and Computer related Innovations.

UNIT – IV:

Trademarks & Trade Secrets: Introduction to Trademarks – Trademark Laws – Functions of Trademark – Marks Covered under Trademark Law - Trade Mark Registration – Maintenance – Transfer - Deceptive Similarities - Infringement – Remedies.

Introduction to Trade Secrets – Laws Relating to Trade Secrets – Safeguarding Trade Secrets – Physical Security – Employee Access Limitation – Confidentiality Agreements – Breach of Contract – Remedies.

UNIT – V:

Cyber Laws and Cyber Crimes: Introduction to Cyber Laws – Information Technology Act 2000 - Protection of Online and Computer Transactions - E-commerce - Data Security – Privacy - Authentication - Confidentiality - Digital Signatures – Certifying Authorities - Cyber Crimes - Prevention - Punishment – Liability of Network Providers.

Outcomes:

After studying these units, the student is expected to be able to assume:

- The significance of innovations, distinguish different kinds of IPRs and know the legislative framework, practice and procedure relating to Patents, Copyrights, Trademarks, Designs, Trade Secrets, Geographical Indications, Traditional Knowledge and certain emerging areas.
- The various components of copyright law, its protection and enforcement to know the application of copyright law, its duration, advantages and issues of 'fair use' and 'plagiarism' in the digital era.

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- The Patent law in India and its global instruments and spell out the procedural requirements of novelty, non-obviousness and inventive step involved in obtaining a Patent, its exclusive rights besides assignment and licensing patterns, commercial exploitation and how the patent does benefit the society.
- The conceptual and legal framework relating to Trade Marks and its infringement and gives an insight how the Trademark is commercially advantageous to its owner to prevent unfair competition and further safeguarding the trade secrets of the business enterprises.
- The importance of E-commerce, data security, online transactions and how the confidentiality and privacy can be safeguarded through the digital signatures and the prevention and punishment of cybercrimes under the law.

Texts Books:

1. Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, New Delhi.
2. Deborah E.Bouchoux: Intellectual Property, Cengage Learning, New Delhi.
3. PrabhuddhaGanguli: Intellectual Property Rights, Tata Mc-Graw –Hill, New Delhi
4. Richard Stim: Intellectual Property, Cengage Learning, New Delhi.
5. Kompal Bansal &Parishit Bansal Fundamentals of IPR for Engineers, B. S. Publications (Press).
6. Cyber Law - Texts & Cases, South-Western's Special Topics Collections.
7. R.Radha Krishnan, S.Balasubramanian: Intellectual Property Rights, Excel Books. New Delhi.
8. M.Ashok Kumar and MohdIqbal Ali: Intellectual Property Rights, Serials Pub.

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III Year - II Semester		**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
HONORS/MINOR COURSES					

Learning Objectives:
The students are able to:

- Avail the expertise in a specific subject from nation-wide reputed faculty, through MOOC (Massive Open Online Course)/ equivalent department course.
- Enhance knowledge in core subjects.
- Obtain knowledge in inter-disciplinary and job orientated minor courses.
- Acquire the skills for life-long learning.
- Diversify ones understanding of a topic useful to profession.

The departmental courses should be offered in lieu of MOOCS courses in case they are not available in NPTEL/SWAYAM. It is required for the students to do, a minimum of 7 courses to obtain the Honors/Minor degree. To fulfill the criteria of qualifying for Honors/minor degree, additional 20 credits are required.

The list of MOOCS/departmental courses in petroleum engineering is given in Appendix-I to do honors and Appendix-II shows the courses for minor degree in petroleum engineering. To obtain the minor degree for petroleum students the eligible students has to do the courses in any one discipline other than Petroleum Engineering.

The **20 credits** for honors or minor degree should be obtained from the fourth semester to the end of eighth semester. A candidate can take a 4-credit course in each semester during the above-mentioned period. It may be noted that, each eligible student has to get minimum of 8.0 SGPA without any backlogs in each semester to do honors/minor degree.

The eligible student shall register for the course **(Minimum of 12 weeks)** in the SWAYAM/NPTEL portal, offered through online with the approval of Head of the Department, under the guidance and supervision of a mentor/faculty. The student has to earn and submit a certificate by passing the exam conducted by SWAYAM/NPTEL for each course to obtain the required credits. If the student does not pass the subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered either through SWAYAM/NPTEL or department offered course in the next semester with the recommendation of mentor/faculty,

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approved by Head of the Department and shall pass in the examination. In case, of departmental courses also the eligible student should pass the examination in each subject conducted by the department to obtain the certificate.

Outcomes:

The students will be able to:

- Overcome the digital divide in acquiring knowledge skills in fast developing technologies and be a part of digital revolution.
- Become a part of National Resource Pool to contribute the subject specific expertise.
- Assess the academic / professional priorities for future development.
- Develop self-learning skills with open-ended problems, case studies for life-long learning.
- Develop additional knowledge skills in core and inter-disciplinary courses.
- Orient themselves with the learning methodologies outlined in the new educational policy of India.

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III Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**0**	**0**
INDUSTRIAL/RESEARCH SUMMER INTERNSHIP (MC)					

Learning Objectives:
The main objective of the internship is to gain up-to-date, practical experience in the real-working situation, in contrast to information gained during studies concerning mainly theoretical background of petroleum engineering.

The students are guided (through the Industry representative) to learn the following aspects:

- Application of the engineering skills, learned in class room, in real world.
- Working as a team to deliver the results along with senior engineering professionals, technicians, managers etc.
- Working safely in industrial environment.
- Result oriented approach in plant operation, troubleshooting and engineering work.
- Present and / or report the work / project outcomes to various disciplines, departments & interest groups with confidence.

Every Student should undergo summer training (summer internship program) in a fertilizer industry/ chemical processing industry/ petroleum refinery/petrochemical complex for 6-8 weeks and submit a report.

Outcomes:
The students will be able to:

- Work safely in Industrial environment.
- Work with various interest groups, disciplines, professionals, managers, technicians etc.
- Polish the engineering skills by applying the knowledge in day-to-day operations, trouble-shooting and minor-modifications.
- Build relations between University and Industry that will help mutual cooperation over long-term.
- Develop/strengthen the basic skills of interviewing, analysis, report writing, communication, decision-making, and problem solving.

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SEM VII (FOURTH YEAR)

IV Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
DESIGN OF SURFACE FACILITIES (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The details of surface facilities for oil and gas processing.
- The concepts of separation and design of separators.
- The concepts of oil field emulsion and electrical emulsion resolution.
- The concepts for the design and operation of desalting and heater treater equipment for crude oils.
- The design principles of the vapor recovery system.
- The various methods of produced water treatment and design principles of water treating equipment.
- The types of heat exchangers & storage tanks and their design for surface facilities.
- The methods of injection of water and gas along with the design of pumps and compressors.
- The concepts of natural gas processing.
- The design principles of pipelines for oil and gas transport.

UNIT-I
Surface facilities: Oil and gas properties, equipment for surface facilities for onshore and offshore production of oil and gas.

UNIT-II
Separation of oil and gas: Equilibrium flash calculations, types of separators and internal part of a separator, factors influencing separation-separator design using actual separator data.

UNIT-III
Oil field emulsion and their electrical emulsion resolution: Theory of emulsion and desalting, dehydration: Heat, chemical additives and electrical treatments-Electrical dehydrators, automated dehydration, operating procedures- resolution of oil in water emulsion-trouble shooting-water oil treatment system.

UNIT-IV

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Vapor recovery: Evaporation, fundamentals of vapor recovery system-equipment required-design of vapor recovery system.

Design of produced water treatment methods: Various methods-design of equipment.

Design of heat exchangers and storage tanks for surface facilities: Various types of heat exchangers- design of double pipe and shell & tube heat exchangers-classification of aboveground storage tanks and their design.

UNIT-V

Injection of water and gas: Design of pumps and compressors.

Natural gas processing: Gas specifications of natural gas – gas sweetening - gas dehydration.

Oil and gas transport in pipelines: Design of gas gathering lines. Design of cross country pipelines for oil and gas transportation.

Outcomes:

The students are able to:

- Assess the requirement of surface facilities for oil and gas processing.
- Design various types of separators.
- Design desalting, emulsifying, and heater treater equipment.
- Design the vapor recovery system.
- Assess the various methods of produced water treatment and their design.
- Design exchangers and storage tanks for surface facilities.
- Assess the requirement of water and gas injection. Therafter, design suitable pumps and compressors.
- Design equipment for dehydration, acid removal and NGL separation in natural gas processing.
- Design of pipelines for oil and gas transport.

Text Books:

1. Surface Production Operations : Design of Oil Handling Systems and Facilities, Volume 1, Third Edition, Maurice Stewart & Ken E. Arnold, Gulf Professional Publishing, 2007.
2. Surface Production Operations: Design of Gas-Handling Systems and Facilities, VOLUME II, Third Edition, Maurice Stewart, Gulf Professional Publishing, 2014.

Reference Books:

1. Surface Production Operations: Facility Piping and Pipeline Systems, Volume III, Third Edition, Maurice Stewart, Gulf Professional Publishing, 2016.
2. Surface Production Operations: Volume IV: Pumps and Compressors, Volume III, Maurice Stewart, Gulf Professional Publishing, 2019.
3. Above ground storage tank, Philip E. Myers, McGraw Hill, 1997.
4. Petroleum and Gas Field Processing, H. K. Abdel-Aal and Mohamed Aggour and M.A. Fahim, Marcel Dekkar Inc., 2003.

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IV Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
RESERVOIR MODELING & SIMULATION (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- Theoretical and working knowledge of reservoir simulation models of varying complexities:
  - Single-phase fluid equations in multiple dimensions
  - Volume finite difference approaches
  - Block centered grids
  - Point distributed grids
  - Well representation
- The applicable numerical methods for the solution of simple and complex reservoir.
- The various simulation models.
- The iterative solution methods for simulation.
- The parametric analysis of reservoir simulation models.

UNIT-I:
Introduction: Milestones for the engineering approach-Importance of the engineering and mathematical approaches.
Single-phase fluid equations in multidimensional domain: Properties of single-phase fluid Properties of porous media- Reservoir discretization- Basic engineering concepts-Multidimensional flow in Cartesian coordinates- Multidimensional flow in radial-cylindrical coordinates.

UNIT-II:
Flow equation using CVFD terminology: Introduction- Flow equations using CVFD terminology- Flow equations in radial-cylindrical coordinates using CVFD terminology- Flow equation using CVFD terminology in any block ordering scheme.

UNIT-III:
Simulation with a block-centered grid: Introduction- Reservoir discretization- Flow equation for boundary grid blocks- Treatment of boundary conditions- Calculation of transmissibilities-Symmetry and its use in solving practical problems.

UNIT-IV:

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Simulation with a point distributed grid: Introduction- Reservoir discretization-Flow equation for boundary grid points-Treatment of boundary conditions-Calculation of transmissibilities - Symmetry and its use in solving practical problems.

Well representation in simulators: Introduction- Single block wells- Multi block wells-Practical considerations dealing with modeling and well conditions.

Petroleum Engineering-Single-phase flow equations for various fluids: Pressure dependence of fluid and rock properties-General single-phase flow equation in multi dimensions.

UNIT-V

Linearization of flow equation: Introduction- Nonlinear terms in flow equations-Nonlinearity of flow equations for various fluids- Linearization of nonlinear terms-Linearized flow equations in time.

Methods of solution of linear equations: Direct solution methods- Iterative solution methods.

Simulation packages: Case studies using packages such as CMG, COMSOL, FLUENT and MATLAB.

Outcomes:

The students are able to:

- Develop simple mathematical models to represent the reservoir production using mathematics and fundamentals of fluid flow.
- Enhance the complexity of mathematical model to represent realistic reservoir conditions.
- Represent the actual well production in simulators to simulate the performance.
- Apply model solution approaches using linearization and method of linear equations.
- Use software packages for reservoir characterization.

TEXT BOOK:

1. Petroleum Reservoir Simulation: A Basic Approach, Jamal H. Abou – Kasem, S. M. Fariuq Ali, M. Rafiq Islam, Gulf Publishing Company, 2006.

REFERENCE BOOKS:

1. Principles of Applied Reservoir Simulation, John R. Fanchi, Elsevier, 2005.
2. Practical Reservoir Simulation, M.R. Carlson, PennWell, 2003.
3. Reservoir Simulation: Mathematical Techniques in Oil Recovery, Zhangxin Chen, Cambridge University Press, 2008.
4. Mathematics of Reservoir Simulation, Richard E. Ewing, Society for Industrial and Applied Mathematics (SIAM), 1983.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
SUBSEA ENGINEERING (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The overview of subsea engineering and field development.
- The concepts of subsea distribution system, control and power supply.
- The details of the subsea vessels for installation and positioning.
- The concepts of Subsea System Engineering including flow assurance, hydraulics and operability.
- The issues related to wax, asphaltenes and hydrates.
- The basic concepts of heat transfer & thermal insulation with reference to flow assurance
- The concepts of subsea corrosion and sand management.

UNIT-I
Overview of Subsea Engineering: Introduction – Subsea production systems – Flow Assurance & System engineering – Subsea structures & Equipment – Subsea pipelines.
Subsea Field Development: Subsea field development overview – Deepwater or Shallow-Water development – Wet Tree & Drain tree systems – Subsea Tie-back development – Stand-Alone development – Artificial lift methods and Constraints – Subsea processing – Template, Clustered Well Systems & Daisy chain –Subsea field development assessment.

UNIT-II
Subsea Distribution System: Introduction – Design Parameters – SDS component design requirements.
Subsea Control: Introduction – Types of control systems – Topside equipment – SCMMB – SCM – Subsea transducers & Sensors – HIPPS – SPCS – IWOCS.
Subsea Power Supply: Introduction – Electrical power system – Hydraulic power system.

UNIT-III
Installation of Vessels: Introduction – Typical installation vessels – Vessel requirements & selection – Installation - positioning & Analysis.
Subsea System Engineering: Introduction – Typical flow assurance process - System design & Operability.

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Hydraulics: Introduction – Composition & Properties of hydrocarbon – Emulsion – Phase behaviour – Hydrocarbon flow – Slugging & Liquid handling – Slug catcher design – Pressure surge – Line sizing.

UNIT-IV

Wax &Asphaltenes: Introduction - wax - wax management – wax remediation – asphaltenes – asphaltenes control design philosophies.

Hydrates: Introduction – physics & phase behaviour – hydrate prevention – hydrate remediation – hydrate control design philosophies – recovery of thermodynamic hydrate inhibitors.

UNIT-V

Heat Transfer & Thermal Insulation: Introduction – heat transfer fundamentals – u value – steady state heat transfer – transient heat transfer – thermal management strategy & insulation.

Subsea Corrosion & Scale: Introduction – pipeline internal corrosion – pipeline external corrosion – scales – overview of erosion & sand management.

Outcomes:

The students are able to:

- Assess the aspects of subsea engineering and field development.
- Apply the concepts of subsea distribution system, control and power supply.
- Plan and select the subsea vessels for installation and positioning.
- Apply the concepts of subsea system engineering including flow assurance, hydraulics and operability.
- Assess the issues related to wax, asphaltenes and hydrates.
- Apply the concepts of heat transfer & thermal insulation for flow assurance.
- Apply the concepts of corrosion and sand management in subsea operations.

Text Books:

1. Subsea Engineering Handbook, Yong Bai & Qiang Bai, Gulf Professional Publishing, New York, 2012.

Reference Books:

1. Offshore Drilling and Completions Training Manual, Drill – Quip, Inc.
2. Manual on Subsea Technology, IOGPT, ONGC.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
HSE IN PETROLEUM INDUSTRY (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The environment issues and all related acts.
- The properties of drilling fluids and its toxic effects on environment.
- The methods to dispose of drilling cuttings after appropriate treatment.
- The different methods for treatment of produced water and its disposal as per pollution control board norms.
- The oil mines regulations.
- The application of HAZOP in various petroleum operations.
- The concepts of disaster management.

UNIT-I
Introduction to environmental control in the petroleum industry: Overview of an environmental impact studies as per the norms - a new attitude-air emissions
Drilling and production operations: Drilling- production.

UNIT-II
The impact of drilling and production operations: Measuring toxicity- hydrocarbons- salt- heavy metals- production chemicals- drilling fluids- produced water- nuclear radiation- air pollution- acoustic impacts- effects of offshore platforms- risk assessment.
Environmental transport of petroleum wastes: Surface paths- subsurface paths- atmospheric paths, planning for environmental protection.
Waste treatment methods: Treatment of water- treatment of solids- treatment of air emissions-waste water disposal: surface disposal.

UNIT-III
Oil mines regulations: Introduction-returns, notices and plans- inspector, management and duties- drilling and workover- production- transport by pipelines- protection against gases and fires- machinery, plants and equipment- general safety provisions- miscellaneous-remediation of contaminated sites- site assessment- remediation process.

UNIT-IV

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Toxicity, physiological, asphyxiation, respiratory, skin effect of petroleum hydrocarbons and their mixtures - sour gases with their threshold limits-toxicity of additives for acidizing and hydro-fracturing.

UNIT-V

Hazard identification- Hazard evaluation- HAZOP and what if reviews- developing a safe process and safety management- personal protection systems and measures – safe installation and operation of electrical equipment.

Classification of fires- the fire triangle- distinction between fires and explosions- flammability characteristics of liquids and vapors- well blowout fires and their control- fire fight equipment- suppression of hydrocarbon fires.

Outcomes:

The students are able to:

- Assess the environment issues.
- Design safe drilling fluids and control the toxic effects of drilling fluids on environment.
- Devise different methods drill cuttings disposal.
- Assess the different methods for treatment of produced water and select appropriate methods.
- Implement the oil mines regulations in petroleum operations.
- Apply the HAZOP in various petroleum operations to identify the risk.
- Apply the concepts of disaster management to prevent accidents.

Text Books:

1. Environmental Control in Petroleum Engineering, John C. Reis, Gulf Publishing Company, 1996.
2. Application of HAZOP and What if Reviews to the Petroleum, Petrochemical and Chemical Process Industries, Dennis P. Nolan, Noyes Publications, 1994.
3. Oil Industry Safety Directorate (OISD) Guidelines, Ministry of Petroleum & Natural Gas, Government of India and Oil Mines Regulations-1984, Directorate General of Mines Safety, Ministry of Labor and Employment, Government of India.

Reference Books:

1. Guidelines for Process Safety Fundamentals in General Plant Operations Centre for Chemical Process Safety, American Institute of Chemical Engineers, 1995.
2. Guidelines for Fire Protection in Chemical, Petrochemical and Hydrocarbon Processing Facilities, Centre for Chemical Process Safety, American Institute of Chemical Engineers, 2003.

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3. Guidelines for Hazard Evaluation Procedures Centre for Chemical Safety, Wiley- AIChE, 3rd Edition, 2008.
4. Guideline for Process Safety Fundamentals in General Plant Operations, Centre for Chemical Process Safety, AIChE, 1995.
5. Chemical Process Industry Safety, K S N Raju, Mc Graw Hill, 2014.

IV Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

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WELL STIMULATION
(PROFESSIONAL ELECTIVE)

Learning Objectives:
The students will be able to learn:

- The basic concepts of rock mechanics and their relevance to design stimulation task in a petroleum reservoir.
- The analysis of Simple 2D, Pseudo 3D and Real 3D analytical models to represent hydraulic fracturing.
- Working knowledge of fracturing fluids and their additives.
- Working knowledge of the rheology of fracturing fluids and their properties.
- The Data requirements for the design of a fracturing task.
- The Pressure decline analysis and interpretation techniques.
- The Practical limitations in fracture design.
- The Prediction of fracture height and various approaches for post-treatment measurements.
- The evaluation of post treatment and performance of fractured wells.

UNIT-I:
Reservoir justification of stimulation treatments: Introduction - Fundamentals of pressure transient analysis- Well and reservoir analysis.
Elements of rock mechanics: Basic concepts- Pertinent rock properties and their measurement- In-Situ stress and its determination.

UNTI-II:
Modeling of hydraulic fractures: Conservation laws and constitutive equations- Fracture propagation models- Fluid flow modeling- Acidizing and acid fracturing.
Fracturing fluid chemistry: Water base fluids- Oil base fluids- Multiphase fluids- Additives- Execution.

UNIT-III:
Fracturing fluid proppant and characterization: Rheology- Shear and temperature effects on fluid properties- Foam fracturing fluids- Slurry rheology- Proppant transport- Fluid loss- Formation and fracture damage- Proppants.
Pre-Treatment data requirements: Types of data- Sources of data- Dynamic downhole testing.

UNIT-IV:
Fracturing diagnosis using pressure analysis: In-situ stresses and fracture directions - Basic relations- Pressure during pumping- Analysis during closure- Combined analysis pumping and closure- Field procedures.

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The optimization of propped fracture treatments: Physical systems and mathematical formulations- Treatment optimization design procedure- Parametric studies of fracture design variables.

Considerations in fracture design: Size limitations- Considerations with predetermined size or volume- Benefits of high proppant concentrations- Effect of reservoir properties- Effects of perforations on fracture execution.

UNIT-V:

Fracture-Height predictions and post-treatment measurements: Linear fracture-mechanics modeling for fracture height- Fracture-height prediction procedures- Techniques to measure fracture height.

Post-treatment evaluation and fractured well performance: Selected references before the finite conductivity fracture models- Cinco and Samaniego model- Comments on damaged and chocked fractures- Post-fracture well analysis- Interpretation for finite conductivity fracture wells with wellbore storage- Comparison of production forecasts for untreated and fractured wells- Calculation of the fracture length and conductivity of long-flowing wells.

Outcomes:

The students are able to:

- Apply the working knowledge of various approaches of fracturing.
- Assimilate data for the design of stimulating treatment.
- Analyze and design fracturing approaches for petroleum reservoir stimulation.
- Solve practical problems in reservoir fracturing and remedies to resolve the same.
- Analyze the practical limitations in fracture design.

Text Book:

1. Reservoir Stimulation, Michael. J. Economides, Kenneth G. Nolte, 2nd Edition, Prentice Hall, 1989.

Reference Books:

1. Oil Well Stimulation, Robert S. Schechter, Prentice Hall, 1992.
2. Modern Fracturing Enhancing Natural Gas Production, Michael J. Economides, Tony Martin, ET Publishing, 2007.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
HORIZONTAL WELL TECHNOLOGY (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The basic concepts of horizontal wells and its reservoir properties.
- The knowledge of different types of horizontal wells.
- The Differences between horizontal and vertical fractured wells.
- The testing and flow performance using different equations.
- The critical flow rates for gas and water coning.

UNIT-I:
Overview of horizontal well technology: Introduction- Limitations of horizontal wells- Horizontal well applications- Drilling techniques- Horizontal well length based upon drilling techniques and drainage area limitations- Completion techniques.
Reservoir engineering concepts: Skin factor- Skin damage for horizontal wells- Effective wellbore radius r'_w - Productivity index, *f*- Flow regimes- Influence of areal anisotropy.

UNIT-II:
Steady-state solutions: Steady-state productivity of horizontal wells- Effective wellbore radius of a horizontal well- Productivity of slant wells- Comparison of slant well and horizontal well productivities- Formation damage in horizontal wells- Field histories.
Influence of well eccentricity: Introduction- Influence of well eccentricity- Drilling several wells- Horizontal wells at different elevations.

UNIT-III:
Comparison of horizontal and fractured vertical wells: Vertical well stimulation- Types of fractures- Comparison of horizontal wells and finite conductivity fractures- Horizontal wells in fractured reservoirs- Fractured horizontal wells.
Transient well testing: Introduction-Mathematical solutions and their practical implications- Generalized flow regimes- Pressure response- Detailed well testing flow regimes- Pressure derivatives - Wellbore storage effects- Practical Considerations.

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UNIT-IV:

Pseudo-steady state flow: Generalized pseudo-steady state equation for vertical wells- Shape factors for vertical wells- Shape factors for fractured vertical wells- Shape factors of horizontal wells- Horizontal well pseudo-steady state productivity calculations- Inflow performance of partially open horizontal wells- Inflow performance relationship (IPR) for horizontal wells in solution gas-drive reservoirs- Predicting horizontal well performance in solution gas-drive reservoirs.

UNIT-V:

Water and gas coning in vertical and horizontal wells: Critical rate definition- Vertical well critical rate correlations- Critical rate by production testing- Decline curve analysis- Water breakthrough in vertical wells- Vertical well post-water breakthrough behavior- Characteristics of water cut versus recovery factor plots- Water and gas coning in horizontal wells- Horizontal well breakthrough time in a bottom water drive - Critical rate for horizontal well in edge-water drive reservoir - practical considerations.

Outcomes:

The students are able to:

- Assess various horizontal well technologies.
- Assess the flow performance calculations of horizontal wells.
- Calculate the mathematical solutions to transient well testing for different flow regimes.
- Overcome challenges for different flow rates in horizontal wells.
- Design a horizontal well.

Text Book:

1. Horizontal Well Technology, S. D. Joshi, PennWell Publishing Company, 1991.

Reference Book:

1. Horizontal Wells: Formation Evaluation, Drilling and Production Including Heavy Oil Recovery, Roberto Aguilera, G. M. Cordell, G. W. Nicholl, J. S. Artindete, M. C. Nq., Gulf Publishing Co., 1991.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
PETROLEUM ECONOMICS, POLICIES AND REGULATIONS (PROFESSIONAL ELECTIVE)					

Leaning Objectives:
The students will be able to learn:

- The importance of petroleum sector in the world economy, both the macro and micro-economic environment and as applicable to India.
- The principles, methods and techniques of petroleum engineering economics.
- The concepts of managing and mitigating uncertainty and risk.
- The application of economic methods to evaluate projects.
- The valuing of petroleum assets and the concepts of portfolio management.
- The scenario of demand and marketing of petroleum products.
- The policies and regulations for oil & gas sector.

UNIT-I
Macro-Economic Approach of Petroleum Industry: Political environment related to petroleum industry and issues related to government and corporate interests, need for understanding petroleum economics required to make investment decisions; introduction, role and value of oil & gas, evolution of national oil companies, organization of petroleum exporting countries.

UNIT-II
Principles, Methods and Techniques of Petroleum Engineering Economics: Introduction, outline and key terminologies and generic issues of micro-economic analysis applicable to all sectors of the oil and gas supply chain, capital budgeting and capital efficiency, sources of revenue and cost and profitability analysis, operating expenditures (OPEX) and their fixed, variable and marginal components, economic indicators and yardsticks used to rank asset values (npv, irr, etc.)
Managing and Mitigating Uncertainty and Risk: Risk, uncertainty and decision analysis, analysis of alternative selections and replacements**,** managing and mitigating uncertainty and risk -breakeven and sensitivity analysis, optimization techniques, geopolitical risks and opportunities and hedging strategies to mitigate market and price risks, asset valuation process: fair market value, probability and risk.

UNIT-III

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Prof. K. V. Rao Member	Shri A. Doraiah Member	Shri S. Swarna Raju Member

Application and Project Evaluation: Project lifecycles, optimum economic life and multi-year cash flows, oil fields exploration and drilling operations, estimation of oil reserves and evaluation of an oil property, project financial analysis, project development - utilization oil fields - production operations - oil transportation - crude oil processing.

UNIT-IV

Valuing Petroleum Assets, Portfolios and Companies: Asset valuation process: fair market value, probability and risk, risk adjustments when valuing petroleum reserve categories, the portfolio approach to asset and corporate management, portfolio characterization, balance and diversification.

Demand and Marketing of Petroleum Products: Crude oil fundamentals, price of crude, crude oil prices in transactions, internal markets and prices, marketing and sale of motor, aviation, lubricant, asphalt and propane transportation: fundamentals of transportation, pipelines, oil tankers, downstream transportations, distribution of petroleum products.

UNIT-V

Oil & Gas Policies and Regulations: Petroleum, oil & gas rules and regulations in India, the oil fields regulations and development act, new exploration licensing policy (NELP), functions of directorate general of hydrocarbons, petroleum and natural gas regulatory board.

Case studies: Economic study of an oil filed development project, petrochemical plant project, natural gas liquefaction cost (including industrial and managerial economics).

Outcomes:

The students are able to:

- Assess the importance of petroleum sector in the world economy, both the macro and micro-economic environment and as applicable to India.
- Apply the principles, methods and techniques of petroleum engineering economics in the evolution of petroleum projects.
- Apply the concepts of managing, mitigating uncertainty and risk in the financial aspects of the company.
- Value the petroleum assets.
- Apply the concepts of portfolio management.
- Assess the demand and marketing of petroleum products.
- Apply the policies and regulations in project implementation and operation of petroleum projects.

Text Books:

1. Petroleum Economics and Engineering, Third Edition, Hussein K. Abdel-Aal, Mohammed A. Alsahlawi, CRC Press, 2013.
2. Petroleum Economics, Heriot-Watt University, 2003.

Reference books:

1. The Global Oil & Gas Industry: Management, Strategy and Finance, Andrew Inkpen & Michael H. Moffett, 2011.
2. Petroleum Economics, Jean Masseron, Technip; 4th revised Edition, 2000.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
ENHANCED OIL RECOVERY (EOR) TECHNIQUES (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The concepts of secondary / tertiary recovery of crude oils of reservoirs.
- The fundamentals of injection methods and CO_2 flooding.
- The basic concepts of polymer flooding and its application.
- The basic concepts of alkaline and surfactant flooding and their application.
- The basic concepts of steam flooding, in-situ combustion and microbial techniques for enhanced oil recovery and their applications.
- The environmental issues in enhanced oil recovery methods.

UNIT-I
Introduction: Different secondary and tertiary oil recovery techniques. Methods to improve the recovery factor at pore scale and macro scale, displacement and sweep efficiency.

UNIT-II
Low salinity water flooding:
Gas injection: Introduction, predictive performance, gas injection in carbonate reservoirs, inert gas injection, candidates for gas injection.
Miscible flooding: Introduction, sweep efficiency - high pressure gas injection, enriched gas drive, LPG slug drive; predictive technique, field applications.
Carbon dioxide flooding: Process description, field projects, CO_2 sources- problem areas, designing a CO_2 flood, guidelines for selection of miscible CO_2 projects, Immiscible CO_2 flooding conclusions, CO_2, WAG process.

UNIT-III
Polymer flooding: Introduction, polymer products and theory of use, planning polymer flood projects.
Polyacrylamides: Introduction, polyacrylamides chemistry, application of PAM/AA in enhanced oil recovery, factors affecting flow in porous media, Field considerations- site factors, Field operation.

UNIT-IV
Alkaline flooding: Introduction, types of caustic used, entrapment of residue oil, displacement mechanisms in alkaline flooding, crude oil properties, alkali consumption, pH of injected caustic, effect of sodium ions and sodium chloride, effect of divalent ions.

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Surfactant flooding: Introduction, classification of EOR surfactants, mechanism of oil displacement by surfactant flooding, ultra-low interfacial tension in relation to oil displacement by surfactant flooding, factors influencing oil recovery, surfactant gas flooding for oil recovery, present status of the use of surfactants in oil recovery.

UNIT-V

Steam flooding for enhanced oil recovery: Introduction, theory- screening criteria for steam flood prospects, reservoir rock and fluid properties, heat losses and formation heating, an overview of steam flood modeling, parametric studies in steam flooding, economics of the steam flooding process - Cyclic steam injection - CCS and Steam assisted gravity drainage.

In-situ combustion technology: Introduction, reservoir characteristics, ignition-ignition methods, process in-situ combustion, use of in-situ combustion, conclusions, current status of in-situ combustion.

Microbial EOR: Introduction, Screening criteria for potential microbes, production characteristics and economics.

Outcomes:

The students are able to:

- Assess the secondary / tertiary recovery methods required for specific crude oil reservoirs.
- Design the injection and CO_2 flooding systems.
- Apply the basic concepts of polymer flooding for its design.
- Apply the basic concepts of alkaline and surfactant flooding for their design.
- Design the steam flooding, in-situ combustion and microbial systems for enhanced oil recovery.
- Assess the environmental issues involved in screening and implementing the enhanced oil recovery methods.

Text Books:

1. Applied Enhanced Oil Recovery, AurelCarcoana, Prentice Hall, 1992.
2. Enhanced Oil Recovery, Larry W. Lake, Prentice Hall, 1998.

Reference Books:

1. Enhanced Oil Recovery Processes and Operations, E.C. Donaldson, G. V. Chillingarian, T.F. Yew, Elsevier, 1998.
2. Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, 1991.
3. Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier, 1981.
4. Fundamentals of Enhanced Oil Recovery, H. R. Van Pollew and Associates, PennWell, 1980.
5. Enhanced Recovery of Residual and Heavy Oil, M. M. Schumacher, Noyes Data Corp., 1980.

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6. Recent Advances in Enhanced Oil and Gas Recovery, IstvanLaktos, Academy Kiado, 2001.
7. Enhanced Oil Recovery, Don W. Greew, G. Paul Willfite, Society of Petroleum Engineers, 1998.
8. Enhanced Oil Recovery: Field Planning and Development Strategies, Vladmir Alvarado, Eduardo Marriglee, Gulf Professional Publishing, 2010.

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		3	0	0	3
ASSET MANAGEMENT (PROFESSIONAL ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The principles of asset management for oil and gas industry.
- The details of processes and modeling paradigms needed to develop the skills to increase reservoir output, profitability and decrease speculation.
- The technical diversity of modern reservoir management teams.
- The principles of reservoir management.
- The concepts and terminology to create an interdisciplinary approach for solving day to day problems in petroleum assets.

UNIT-I
Asset Management: The corporate dimension – data gathering – interpreting the main data.

UNIT-II
Developing a Decision Making Frame Work: Populating asset management plans – creating a strategic outline and business case for investment – the corporate asset management plan; developing an integrated asset management and capital planning system.

UNIT-III
Concepts of Reservoir Management: Reservoir management process – data acquisition, analysis and management - reservoir performance analysis and forecast – reservoir management economics – reservoir management case studies.

UNIT-IV
Industrial Asset Management Strategies for the Oil and Gas Sector: Over view of onshore and offshore assets – integration and optimization methodology – a case study in OPEX of the assets – evaluation of asset performance.

UNIT-V
An Asset Management Model: Typical oil field workflow – workflows for asset management – an automated approach to data quality management – change management – risk based asset management model – program evaluation and evaluation techniques (PERT) And Critical path method (CPM) .

Outcomes:

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The students are able to:

- Apply the principles of asset management for oil and gas industry.
- Evaluate the processes and modeling paradigms needed to develop the skills to increase reservoir output, profitability and decrease speculation.
- Develop modern reservoir management teams keeping in mind the technical diversity.
- Implement the concepts of reservoir management.
- Create an interdisciplinary approach for solving day to day problems in petroleum assets.

Text Books:

1. A guide to Asset Management and Capital Planning in Local authorities, CIPFA, 2008.
2. The Big Picture: Integrated Asset Management Cedric Bouleau et al, Oil field Review, 2007/2008.
3. Integrated Petroleum Reservoir Management, A team approach, Abdus, Satter and Ganesh C. Thakur, PennWell, Tulsa, 1994.

Reference Books:

1. Handling Risk and Uncertainty in Petroleum Exploration and Asset Management, American Association of Petroleum Geologists, 2015.
2. Integrated Reservoir Asset Management: Principles and Best Practices: Fanchi John R Fanchi¸ Gulf Professional Publishing, 2010.

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		3	0	0	3
TRANSPORTATION OF OIL AND GAS (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The basic concepts of operations and maintenance of flow lines or trunk pipelines.
- The well fluids for proper designing of flow lines/trunk pipelines.
- The operation and maintenance of crude oil and natural gas pipelines.
- The steady state flow & transient flow in pipeline systems.
- The numerical solution techniques for relatively complex transient fluid flow conditions.

UNIT-I:
Physical and Transport properties: Physical and transport properties of crude oil, Petroleum liquids and Natural gas.

UNIT-II:
Modes of Crude Oil, Hydrocarbon Liquids and Gas Transportation: Tank-Trucks and Rail Transportation, Oceanic Tanker Transportation, Inland Water, Coastal and Oceanic, Tanker Size, Power, Cargo Space, Marine Storage Terminals, Shore Installation – natural gas regasification techniques.

UNIT-III:
Pipeline Transportation of Oil: Crude oil and product flow characteristics, heat flux estimation, the temperature gradient in flowing fluid in exposed and buried pipeline, insulation types and thickness, rheology and non-Newtonian behavior- pressure drop, pumps and booster stations.
Wax and Asphaltenes: Wax; Wax Management; Wax Remediation; Asphaltenes; Asphaltenes Control; Design Philosophies.

UNIT-IV:
Pipeline Transportation of Natural Gas: Temperature of flowing gases; Steady-state flow & Transient flow in pipeline systems**.**

UNIT-V:
Subsea System Engineering: Flow assurance challenges; flow assurance concerns; typical flow assurance process; fluid characterization and property assessments

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Heat Transfer and Thermal Insulation: Heat Transfer Fundamentals; U-Value; Steady-State Heat Transfer; Transient Heat Transfer; optimum insulation thickness calculations. Thermal Management Strategy.
Hydrates: Physics and Phase Behavior; Hydrate Prevention; Hydrate Remediation; Hydrate Control Design Philosophies**.**

Outcomes:
The students are able to:

- Assess the pipeline operations & maintenance.
- Apply the flow assurance challenges for subsea pipelines.
- Assess wax and asphaltenes management strategy and philosophies.
- Classify transportation of crude oil and natural gas pipelines.
- Computer simulation of the subsea systems, hydrates by thermal insulation and heat transfer flow in pipeline system.

Text Books:

1. Production and transport of oil and gas (part B: gathering and transport); Szilas A.P; 2nd Edition, Elsevier publications.
2. Subsea Engineering Handbook; Yong Bai., QiangBai; Gulf Professional Publishing; Elsevier.

References Books:

1. Oil and gas production handbook (An introduction to oil and gas production, transport, refining and petrochemical industry); HåvardDevold; ABB publications.
2. A review of: “Production and Transportation of Oil and Gas”, by A. P. Szilas. Amsterdam: Elsevier Scientific Publishing Company.

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		3	0	0	3
BASICS CONCEPTS IN SEISMIC METHODS FOR HYDROCARBON EXPLORATION (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- Basic principles of petroleum exploration.
- The basic methods viz gravity, magnetic and seismic.
- Principles of seismic refraction, reflection and their acquisition and corrections applied in the field to the data.
- The drillable location based on both seismic refraction and reflection data.
- The basic principles of well seismic survey & VSP survey and utilization of these surveys in the interpretation of 2D, 3D seismic data.

UNIT-I:
Introduction to Geophysical methods: used in oil Industry with emphasis on seismic methods and their historical back ground , basic concepts and the present status of these methods in the industry.

UNIT-II:
Historical back ground of seismic methods: Different types of these methods namely Seismic Refraction, Seismic Reflection, and well seismic methods, Different types of seismic waves.

UNIT-III:
Seismic refraction methods: Geometry of a Refracted wave, single layer and two layer case. Recording instruments & energy sources- Corrections to refraction data Interpretation. Application of seismic refraction method in calculating statics for application in reflection survey.

UNIT IV
Seismic Reflection methods: Geometry of reflected ray path: Single horizontal reflector- The reflection seismograph and seismogram (Seismic traces)- Importance of seismic reflection survey over seismic refraction survey technique.
Field procedures & principles- Receivers and sources. Field Layouts. Time corrections applied to seismic data- Data processing - Introduction to 2D & 3D data acquisition. - Common depth point (CDP) profiling & stacking- data interpretation of reflection data for identification of drillable structures. Marking of reflectors (different lithologic units in the subsurface, construction of time and

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depth structures maps and calculation of reserves based on these identified structures. AVO and seismic inversions.

UNIT V:
Brief introduction to recent advances in seismic methods namely 4D seismic methods, Virtual Reality Centers for interpretation. Well seismic shooting for velocity determination and Vertical Seismic Profiling (VSP) and their importance

Outcomes:
The students are able to:

- Apply the different types of seismic wave propagation, and the theory behind them like Huygene's principle, Snell'law etc.
- Apply the seismic refraction methods and reflection methods for hydrocarbon exploration.
- Use of reflection method in identifying different types of subsurface structures and their interpretation
- Assess the Vertical seismic profiling (VSP) and Well seismic surveys.
- Apply knowledge of the seismic methods for hydrocarbons, viz its different acquisition methods, processing and interpretation.

Text Books:

1. Introduction to Geophysical Prospecting, Milton B. Dobrin, and Carl H. Savit, 4thEdition, McGraw Hill, 1988.
2. Outlines of Geophysical Prospecting: A Manual for Geologists, M.B. Ramachandra Rao, EBD Educational Pvt Ltd., 1993.
3. Field Geophysics, John Milsom and Asger Eriksen, 4thEdition, John Wiley, 2011.

Reference Books:

1. Elements of Geology: Oil and Gas Exploration Techniques, J. Guillemot, Technip 1991.
2. Fundamentals of Geophysics, Lowri, W., Cambridge University Press. (1997).
3. Applied Geophysics, Telford, W. M, Geldart L.P., Sheriff, R.E., Keys, D.A. (1990).

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IV Year - I Semester		L	T	P	C
		3	0	0	3
BASICS CONCEPTS IN ARTIFICIAL LIFT METHODS (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The various artificial lift methods for the secondary recovery of the field.
- The sucker rod lift system and the problems related to SRP operations.
- The gas lift mechanism and design.
- The different types of submersible pumps.
- The skills for the selection and type of artificial lift method for wells.

UNIT-I
Introduction: Definition and Purpose of artificial lift selection-Reservoir pressure and well productivity-reservoir fluids-Types of artificial lift.

UNIT-II
Sucker Rod lift: Sucker rod lift system-polished rod motion-load to the pumping unit-pump deliverability and power requirement-sucker rods-steel sucker rods-pony rods-FRP sucker rods-Non-API sucker rods-criteria for rod string design, advantages and limitations-Trouble shooting sucker rod lift installation.

UNIT-III
Gas lift: Gas lift system-gas compression requirements sonic flow-subsonic flow-volumetric efficiency-stage compression-gas lift valve design-selection of gas lift valves-pilot valve continuous and intermittent gas lift advantages and limitations.

UNIT-IV
Electrical submersible pumps: Electrical submersible pumps. (ESP)- Principle - hydraulic piston pumping-ESP design-ESP advantages and limitations.

UNIT -V
Hydraulic Jet pumping: Hydraulic Jet pumping-selection of jet pump-advantages and disadvantages.
Selection of artificial lift method: artificial lift method selection-gas lift vs pump assisted lift installation and replacement of artificial lift-maintenance of artificial lift.

Outcomes:
The students are able to:

- Assess the Oil well artificial lift techniques.
- Apply knowledge of mechanical systems specific to oil lifting from crude oil wells.

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- Assess the various artificial lift methods for the secondary recovery of the field.
- Assess the sucker rod lift system and the problems related to SRP operations.
- Apply the gas lift mechanism and design.
- Differentiate the types of submersible pumps and their applications.
- Apply the skills for the selection and type of artificial lift method.

Text books:

1. Petroleum Production engineering: A computer assisted approach, Boyun GUO, William C. Lyons, Ali Ghalambor, Elsevier Science and Technology books 2007.
2. Petroleum Engineering Handbook-Production Operations Engineering, Volume 4, Joe Dunn Clegg and Larry W. Lake, SPE, 2014.

Reference Books:

1. Petroleum production systems, M.J. Economides, A. Daniel Hill & C. E. Economides, Prentice-Hall, N.J-07488, 1994.
2. The Technology of Artificial Lift Method, Brown, K.E, Volume 1-4, Penn Well Books, Tulsa, Oklahoma, 1977.
3. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University, 2014.
4. Sucker rod pumping Handbook, Gabor Takacs, Elsevier Inc.,2015.
5. Gas lift Manual, Gabor Takacs, Elsevier Inc., 2013.

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		3	0	0	3
DEEPWATER TECHNOLOGY (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- The basic concepts of subsea development operations.
- The fundamentals on deep-water exploration & drilling.
- The knowledge on fixed platforms, compliant towers, subsea systems and floating production systems.
- Knowledge on deep-water applications of subsea technology
- The applications of deep-water pipelines, umbilical's and emerging deep-water technologies.

UNIT-I:
Introduction: Definition, Global Deep-water reserves & development activity. Technological advances. Dynamics of Offshore structure: Analysis of waves and fluid induced forces on offshore structures, Current and wind forces, Soil mechanics of seabed & structures.

UNIT-II:
Deep-water Exploration & Drilling: Seismic /Seabed survey, constraints in deepwater survey like geo-hazards, gas hydrate etc., Deep water drilling with emphasis on the additional inputs to normal offshore Drilling operation.

UNIT –III:
Deep-water Production System: Fixed Platforms, Compliant Towers, Subsea systems, Extended Reach Wells, Floating production systems like FPSO, FPSS, TLPS, Spar platform and FSO.

UNIT-IV:
Deep-water applications of Subsea Technology: Subsea completion, X-mas tree, Control systems, Manifolds, Templates, ROV, Deepwater installation vessels with DP system and associated problems – Offshore mobile units, station- keeping methods like mooring and dynamic positioning system.

UNIT-V:
Deep-water pipelines, Umbilical's & emerging Deep-water Technologies:
Issues in Deep-water pipeline design, Rigid and Flexible flow lines, pipe-in-pipe, Deep-water Risers and their configurations, Pipeline installation methods, Umbilical's-functions, configurations and installation, Flow assurance strategies,

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Innovative floating production concepts, subsea processing, subsea separation and any new innovations.

Outcomes:

The students are able to:

- Analysis of waves and fluid-induced forces on offshore structures, Current and wind forces.
- Understand the Deepwater exploration and Deepwater drilling techniques.
- Apply the concepts of fixed platforms, compliant towers, subsea systems, extended reach wells and floating production systems.
- Extend innovative subsea completion, installation and associated problem.
- Demonstrate deep-water pipelines, flow assurance strategies and subsea innovations.

Text Books:

1. Subsea Engineering Handbook, Yong bai and Qiangbai, Gulf Professional Publishing, 2010.
2. Offshore Petroleum Drilling and Production, By Sukumar Laik, 1st Edition, Published June 30, 2020 by CRC Press.
3. Deepwater Petroleum Exploration & Production by William L. Leffler, Richard Pattarozzi, Gordon Sterling Penn Well Books, 2003.

Reference Books:

1. Floating Drilling: Equipment and Its Use, by Riley Sheffield Volume 2 of Floating Drilling and Volume 2 of Practical drilling technology-1980
2. Handbook On Nondestructive Testing of Concrete By V.M. Malhotra And N.J. Carino, Second Edition Crc Press-2004
3. Offshore Handbook Vol.1 to 5: Gulf Pub. Co.
4. Offshore Pipeline Design, Analysis, and Methods by A. H. Mousselli, Publisher, Penn Well Books, 1981.
5. Drilling and Producing Offshore, by R. Stewart Hall, Publisher, Pennwell Corp- 1984.

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		3	0	0	3
BASICS CONCEPTS OF ACIDIZING AND HYDRO-FRACTURING (OPEN ELECTIVE)					

Learning Objectives:
The students will be able to learn:

- Modeling of hydraulic fracture for different reservoirs.
- The fracturing fluid properties and their usage.
- Fracturing fluid proppant characterization for different formations.
- The methods of matrix acidization and fracture acidization.
- The concepts of hydraulic fracturing and its design.

UNIT-I:
Modeling of hydraulic fractures: Conservation laws and constitutive equations, fracture propagation models, fluid flow modeling, acid fracturing.

UNIT-II:
Fracturing fluid chemistry: Water base fluids, oil base fluids, multiphase fluids, additives execution.

UNIT-III:
Fracturing fluid proppant and characterization: Rheology, shear and temperature effects on fluid properties, foam fracturing fluids, slurry rheology, proppant transport, fluid loss, formation and fracture damage, and proppants.

UNIT-IV:
Matrix acidization and fracture acidization: Well Stimulation acids, matrix acidizing carbonate formations, fracture acidizing carbonate formations, Acid–rock interaction, sandstone acidizing design, carbonate acidizing design.

UNIT-V:
Hydraulic Fracturing: Introduction, formation fracturing pressure, fracture geometry, productivity of fractured wells, stimulated reservoir volume (SRV) - hydraulic fracturing design.

Outcomes:
The students are able to:

- Apply the modeling of hydraulic fractures for different reservoirs.
- Assess fracturing fluid properties and their usage.
- Analyze the fracturing fluid proppant characteristics.

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- Apply the methods of matrix acidization and fracture acidization.
- Apply the concepts of hydraulic fracturing and its design.

Text Book:

1. Reservoir Stimulation, Michael. J. Economides, Kenneth G. Nolte, 2nd Edition, Prentice Hall, 1989.

Reference Books:

1. Oil Well Stimulation, Robert S. Schechter, Prentice Hall, 1992.
2. Modern Fracturing Enhancing Natural Gas Production, Michael J. Economides, Tony Martin, ET Publishing, 2007.

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		3	0	0	3
FUNDAMENTALS OF EOR TECHNIQUES (OPEN ELECTIVE FOR OTHER BRANCHES)					

Learning Objectives:
The students will be able to learn:

- The Classification and description of EOR processes.
- The microscopic displacement of fluids viz. capillary forces, viscous forces and phase trapping.
- The fundamentals of gas injection.
- The basic concepts of polymer flooding and its application.
- The basic concepts of alkaline and surfactant flooding and their application.
- The basic concepts of steam flooding, in-situ combustion and microbial techniques for enhanced oil recovery and their applications.

UNIT-I
Overview: Definition of EOR - Target oil resource for EOR process - Idealized characteristics of an EOR process - General Classification and description of EOR process

UNIT-II
Microscopic and Macroscopic Displacement of Fluids in a Reservoir:
Introduction - Capillary forces - viscous forces – phase trapping - displacement and sweep efficiency.
Gas injection: Introduction, gas injection in carbonate reservoirs, inert gas injection.

UNIT-III
Miscible Flooding: Introduction, - sweep efficiency - high pressure gas injection - field applications.
Carbon dioxide flooding: Process description, CO2 sources- guidelines for selection of miscible CO2 projects.

UNIT-IV
Alkaline Flooding: Introduction, types of caustic used, entrapment of residue oil, displacement mechanisms in alkaline flooding, crude oil properties.
Polymer Flooding: Introduction, polymer products and theory of use, planning polymer flood projects.
Polyacrylamides: Introduction, polyacrylamides chemistry, application of PAM/AA in enhanced oil recovery, factors affecting flow in porous media, Field operation.

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Surfactant Flooding: Introduction, classification of EOR surfactants, mechanism of oil displacement by surfactant flooding.

UNIT-V

Steam Flooding: Introduction, theory- screening criteria for steam flood prospects, reservoir rock and fluid properties.

In-situ Combustion Technology: Introduction, reservoir characteristics, process in-situ combustion, use of in-situ combustion, conclusions, current status of in-situ combustion.

Outcomes:

The students are able to:

- Classify and describe EOR processes.
- Assess the microscopic displacement of fluids viz. capillary forces, viscous forces and phase trapping.
- Apply the fundamentals of gas injection.
- Apply the basic concepts of polymer flooding.
- Analyze the basic concepts of alkaline and surfactant flooding and their application.
- Assess the applications of steam flooding, in-situ combustion and microbial techniques for enhanced oil recovery.

Text Books:

1. Applied Enhanced Oil Recovery, Aurel Carcoana, Prentice Hall, 1992.
2. Enhanced Oil Recovery, Larry W. Lake, Prentice Hall, 1998.
3. Enhanced Oil Recovery Processes and Operations, E.C. Donaldson, G. V. Chillingarian, T.F. Yew, Elsevier, 1998.

Reference Books:

1. Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, 1991.
2. Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier, 1981.
3. Fundamentals of Enhanced Oil Recovery, H. R. Van Pollew and Associates, PennWell, 1980.
4. Enhanced Recovery of Residual and Heavy Oil, M. M. Schumacher, Noyes Data Corp., 1980.
5. Recent Advances in Enhanced Oil and Gas Recovery, IstvanLaktos, Academy Kiado, 2001.
6. Enhanced Oil Recovery, Don W. Greew, G. Paul Willfite, Society of Petroleum Engineers, 1998.
7. Enhanced Oil Recovery: Field Planning and Development Strategies, Vladmir Alvarado, Eduardo Marriglee, Gulf Professional Publishing, 2010.

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IV Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY					

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IV Year - I Semester		L	T	P	C
		1	0	2	2
CLOUD COMPUTING (SOFT SKILL COURSE)					

Learning Objectives:

- Ability to understand various service delivery models of a cloud computing architecture.
- Ability to understand the ways in which the cloud can be programmed and deployed.
- Understanding cloud service providers.
- Understand and learn the Characteristics of IaaS and Characteristics of PaaS
- Learn and gain knowledge about the Cloud Service providers.

UNIT-I:

Computing Paradigms: High-Performance Computing, Parallel Computing, Distributed Computing, Cluster Computing, Grid Computing, Cloud Computing, Bio computing, Mobile Computing, Quantum Computing, Optical Computing, Nano computing.

UNIT-2:

Cloud Computing Fundamentals: Motivation for Cloud Computing, The Need for Cloud Computing, Defining Cloud Computing, Definition of Cloud computing, Cloud Computing Is a Service, Cloud Computing Is a Platform, Principles of Cloud computing, Five Essential Characteristics, Four Cloud Deployment Models.

UNIT-3:

Cloud Computing Architecture and Management: Cloud architecture, Layer, Anatomy of the Cloud, Network Connectivity in Cloud Computing, Applications, on the Cloud, Managing the Cloud, Managing the Cloud Infrastructure Managing the Cloud application, Migrating Application to Cloud, Phases of Cloud Migration Approaches for Cloud Migration.

UNIT-4:

Cloud Service Models: Infrastructure as a Service, Characteristics of IaaS. Suitability of IaaS, Pros and Cons of IaaS, Summary of IaaS Providers, Platform as a Service, Characteristics of PaaS, Suitability of PaaS, Pros and Cons of PaaS, Summary of PaaS Providers, Software as a Service, Characteristics of SaaS, Suitability of SaaS, Pros and Cons of SaaS, Summary of SaaS Providers, Other Cloud Service Models.

UNIT-5:

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Python for Amazon Web Services, Python for Google Cloud Platform, Python for Windows Azure, Python for MapReduce, Python Packages of Interest, Python Web Application Framework – Django, Designing a RESTful Web API. Cloud Application Development in Python, Design Approaches, Image Processing APP, Document Storage App, MapReduce App, Social Media Analytics App, Cloud Application Benchmarking and Tuning, Cloud Security, Cloud Computing for Education.

Outcomes:

At the end of the course, student will be able to

CO1 Explain different types of Computing

CO2 Illustrate Four types of Cloud Deployment Models

CO3 Demonstrate different Phases of Cloud Migration Approaches for Cloud Migration

CO4 Analyze and Develop Cloud Service Models

CO5 Design applications for an organization which use cloud environment.

Text Books:

1. Essentials of cloud Computing: K. Chandrasekhran, CRC press, 2014
2. ArshadeepBhaga, Vijay Madisetti, “Cloud Computing AHandson Approach”, Universities Press, 2018

Reference Books:

1. Cloud Computing: Principles and Paradigms by RajkumarBuyya, James Broberg and Andrzej M. Goscinski, Wiley, 2011.
2. Distributed and Cloud Computing, Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, Elsevier, 2012.
3. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, SubraKumaraswamy, ShahedLatif, O’Reilly, SPD,rp2011.

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IV Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**0**	**3**
INDUSTRIAL/RESEARCH SUMMER INTERNSHIP EVALUATION					

Learning Objectives:

- To give a clear, organized and accurate oral presentation of industrial/research Summer Training/Internship Report.
- To provide verbally/ through power point presentation of condensed large amounts of technical information into concise, condensed analysis.
- Sharing the practical knowledge obtained during training with fellow students.

An industrial/research summer internship report is a documentation of a student's work—a record of the original work done by the student in the industrial/research summer internship of 6 week duration during VII semester.

Industrial/research summer Internship of the students shall be evaluated for 50 marks for weightage of 40% - Report and 60% - oral presentation by a committee constituted by the Head of the Department for evaluation.

Outcomes: Students will extend their abilities to:

- Get themselves good clarity in the technical topics being presented.
- Develop good communication skills.
- Practice the behaviors of effective speakers.
- Assess strengths in speaking and set goals for future growth.

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IV Year - I Semester		**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
HONORS/MINOR COURSES					

Learning Objectives:
The students are able to:

- Avail the expertise in a specific subject from nation-wide reputed faculty, through MOOC (Massive Open Online Course)/ equivalent department course.
- Enhance knowledge in core subjects.
- Obtain knowledge in inter-disciplinary and job orientated minor courses.
- Acquire the skills for life-long learning.
- Diversify ones understanding of a topic useful to profession.

The departmental courses should be offered in lieu of MOOCS courses in case they are not available in NPTEL/SWAYAM. It is required for the students to do, a minimum of 7 courses to obtain the Honors/Minor degree. To fulfill the criteria of qualifying for Honors/minor degree, additional 20 credits are required.

The list of MOOCS/departmental courses in petroleum engineering is given in Appendix-I to do honors and Appendix-II shows the courses for minor degree in petroleum engineering. To obtain the minor degree for petroleum students the eligible students has to do the courses in any one discipline other than Petroleum Engineering.

The **20 credits** for honors or minor degree should be obtained from the fourth semester to the end of eighth semester. A candidate can take a 4-credit course in each semester during the above-mentioned period. It may be noted that, each eligible student has to get minimum of 8.0 SGPA without any backlogs in each semester to do honors/minor degree.

The eligible student shall register for the course **(Minimum of 12 weeks)** in the SWAYAM/NPTEL portal, offered through online with the approval of Head of the Department, under the guidance and supervision of a mentor/faculty. The student has to earn and submit a certificate by passing the exam conducted by SWAYAM/NPTEL for each course to obtain the required credits. If the student does not pass the subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered either through SWAYAM/NPTEL or department offered course in the next semester with the recommendation of mentor/faculty, approved by Head of the Department and shall pass in the examination. In case, of

departmental courses also the eligible student should pass the examination in each subject conducted by the department to obtain the certificate.

Outcomes:

The students will be able to:

- Overcome the digital divide in acquiring knowledge skills in fast developing technologies and be a part of digital revolution.
- Become a part of National Resource Pool to contribute the subject specific expertise.
- Assess the academic / professional priorities for future development.
- Develop self-learning skills with open-ended problems, case studies for life-long learning.
- Develop additional knowledge skills in core and inter-disciplinary courses.
- Orient themselves with the learning methodologies outlined in the new educational policy of India.

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SEM VIII (FOURTH YEAR)

IV Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**0**	**12**
PROJECT AND SEMINAR (INDUSTRIAL INTERNSHIP/IN-HOUSE)					

Learning Objectives:

The students are able to learn to:

- Explore the given/chosen topic in detail by doing literature search from journals articles and books.
- Identify the gaps in the existing research/technology.
- Formulate the problem statement of the project and to work out the methodology of addressing the topic.
- Make some preliminary investigations on the topic experimentally or theoretically or both.
- Make an interim technical report consisting of preliminary investigations for presenting it to a committee.
- The design and simulation aspects for the topics necessary in the project work.
- The integration of knowledge gained in gathering the information required for the project.
- The improvement of personal qualities like maturity, initiative and creativity.
- The solutions to problems of a non-routine nature.
- The compilation of the work for final technical report to present it in a committee.
- The evaluation of the usage / commercial /environmental aspect of a production / supply or regulation point of view.

The project work may consist of any one of the following:

The project work may consist of any one of the following:

a) The project work should consist of a comprehensive design project of any one of the petroleum upstream processes concerned with reservoir, drilling, production, surface production operations, stimulation, enhanced oil recovery in the form of a report.
b) Modeling & Simulation of any petroleum upstream unit concerned with reservoir, drilling, production, surface production operations, stimulation, enhanced oil recovery.

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c) Any experimental work with physical interpretations.
d) The internship in petroleum industry.

The project work shall be evaluated for 200 marks (12 credits), 60 marks shall be for Internal Evaluation and 140 marks for the End Semester Examination. The End Semester Examination (Viva-Voce) shall be conducted by the committee. The committee consists of an external examiner, Head of the Department and Supervisor of the Project. The evaluation of project work shall be conducted at the end of the IV year. The Internal Evaluation shall be on the basis of two seminars given by each student on the topic of his/her project and evaluated by an internal committee.

Outcomes:

The students are able to:

- Carry out literature survey for any project.
- Do research work by bridging the gaps in the existing research/technology.
- Write the problem statements of any projects.
- Develop methodology to make calculations/simulations.
- Make the interim technical reports for the preliminary investigations.
- Carry out design and simulation of equipment and processes required for the project.
- Be competent in experimental work and subsequent analysis involving research methodology.
- Integrate the knowledge gained in gathering the information.
- Identify the gaps between theory and practice.
- Improve the personal qualities like maturity, initiative and creativity.
- Develop communication skills, both oral and written.
- Solve the problems of non-routine nature.
- Compile the final technical report for presenting it to a committee.
- Prepare a comprehensive project in a planned manner, within specified time and present the salient features of the results to the audience with confidence and clarity.

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