Course Name	**Web enabled PG Level Advanced Certification Programme in Applied Petroleum Engineering and Hydrogen Energy (PGPEH) - Upstream**
Course Name as on Certificate	**Applied Petroleum Engineering and Hydrogen Energy (PGPEH) - Upstream**
Certificate Type	Certificate of Completion by IITM Pravartak and Zemblance Hydrocarbons
Certificate Issued by	IITM Pravartak and Zemblance Hydrocarbons
Course Objectives	To provide students with advanced knowledge and skills in various areas of petroleum engineering, including strategic corporate finance, risk analysis, decision-making, drilling technologies, reservoir modeling, energy alternatives, and the application of advanced technologies such as machine learning and artificial intelligence in the oil and gas industry. The course aims to equip students with the necessary expertise to address complex challenges in the field of petroleum engineering, make informed decisions, optimize production and reservoir management, and explore sustainable and alternative energy sources. By the end of the course, students will be equipped with the knowledge and skills necessary to analyze complex energy and petroleum systems, make informed decisions, and contribute to the sustainable development and management of energy resources.
Eligibility	•Graduation in Engineering - Petroleum/Chemical/Mechanical/Civil/Mining/ Electrical/Electronics and Masters in Geophysics/Geology/Applied Geology from recognized university (UGC/AICTE/DEC/AIU/State Government). •For International Participants - Students / Graduation or equivalent degree from any recognized University or Institution in their respective country.
Pre-Requisites	Fundamental knowledge of science, engineering, energy sector
Target Segment	Graduation in Engineering - Petroleum/Chemical/Mechanical/Civil/Mining/ Electrical/Electronics and Masters in Geophysics/Geology/Applied Geology
Course Content	**See Enclosed Programme details – as Annexure**
Pedagogy	12 Months 12 sessions/week 5 live sessions/month Each recorded session will be 25 minutes and uploaded to the server and participants can get access.
Assessment	Online, at the mid of the session and at the end.
Programme Faculty	Industry Professionals who has vast expertise and IIT Madras, University of Wyoming, Curtin University
Duration	12 Months

Class schedule	Candidates can access to uploaded recorded sessions anytime, for each course 2 Teaching Assistants will be provided and 5 live sessions in a month for each course will be taken place.
Programme Highlights/USPs	The comprehensive and industry-focused nature of the course, providing students with the necessary knowledge, skills, and opportunities to excel in the energy and petrochemical industries Other Highlights: • Comprehensive Curriculum: Covering a wide range of topics, including upstream, management, hydrogen-biofuels. • Industry-Relevant Knowledge: Understanding of the latest advancements, emerging technologies, and best practices in energy sectors. • Practical Applications: Case studies and projects. • Expert Faculty: Profound faculty members with extensive industry expertise. • Interdisciplinary Approach: Combining engineering principles, financial analysis, environmental considerations, and technological advancements. • Collaboration and Networking: Fostering a supportive learning environment and providing opportunities for mentorship and career development. • Career Prospects: Career opportunities in energy companies, petrochemical industries, consulting firms, government agencies, and research institutions.

Total Fees		**Total Fees (Rs.)**	
	Total Programme Fee	INR as applicable 4,00,000 + 18% GST – Sponsored Candidates 3,00, 000 + 18% GST – Other Candidates	

ANNEXURE

Proposed Course outline / programme / plan

COURSES

Syllabus

For

Web enabled PG Level Advanced Certification Programme in Applied Petroleum Engineering and Hydrogen Energy(PGPEH)

Course List

Module 1: Courses

- Strategic, Corporate Finance, Risk analysis, Green Finance, and decision making
- Advanced oil and gas drilling, Multilateral and horizontal well technology and production engineering
- Reservoir modeling and simulation: Reserve estimation, EOR Techniques, Cap Rock Analysis and integrated reservoir management
- Underground Coal Gasification & Surface Gasification with Applied Thermodynamics: Methods, Technology, Applications
- Renewable Energy (Geothermal, Wind, Solar, and Battery), Bio-Fuels: Production, Transportation, Storage, and Application

Module 2: Courses

- Hydrogen Production I. ethane steam reforming II. Electrolysis III. Biomass
- Hydrogen Transportation and Storage
- Applied Oil and gas seismic data analysis and advanced interpretation
- Petroleum geomechanics and field applications
- Application of Machine Learning (ML) and Artificial Intelligence (AI) in the Oil and Gas Industry

Course	Credit for each	Total Credits
7 Core	10	70
3 Elective	10	30
1 Project	50	150

Total 150 credits

Candidates are evaluated at the end of every term (4 months) based on their performance assignments, end term exam. Program follows Cumulative Grade Point Average (CGPA) system. CGPA is on a scale of 0 to 10. A minimum **D grade** should be obtained by the candidate for obtaining this PGPEH Programme certificate. Letter grades and CGPA are awarded to learners based on the following criteria:

Grade		Remarks
Code	Points	
S	10	---
A	9	---
B	8	---
C	7	---
D	6	---
E	4	---
U	0	---
P	0	Pass
F	0	Fail

$$GPA = \frac{\sum_i (C_i \times GP)}{\sum_i C_i}$$

where C_i = credit of the course

GP = Grade point based on the letter grade obtained for the course

$\sum_i C_i$ = the sum of credits of all courses taken in that term, including those in which the learner has secured U / W grades.

For the CGPA, a similar formula is used where the sum ΣiCi is the sum of the credits of all the courses taken in all the terms successfully completed up to that point in time.

Syllabus- Module: 1

Course Name : Strategic, Corporate Finance, Risk analysis, Green Finance, and decision making

Course Instructor: Dr. M. Thenmozhi; Professor & HOD, Department of Management Studies, IIT Madras

Shri. R K Dhasmana, Former Executive Director and Basin Manager KG Basin, ONGC; EdTech Director, Zemblance Hydrocarbons

Objectives: This course covers strategic corporate finance, risk analysis, green finance, and decision making. Students will learn to assess and manage financial risks within a strategic framework, while considering environmental sustainability. The course explores capital budgeting, financial planning, and valuation techniques in corporate finance. It also focuses on green finance and the integration of ESG factors into financial decision making. By the end of the course, students will be able to analyze financial risks, develop sustainable financial strategies, and make informed decisions that align with corporate social responsibility and environmental stewardship.

Course Contents:

Introduction to Strategic Corporate Finance: Role of finance in corporate, strategy, Financial goals and objectives

Financial Risk Analysis: Types of financial risks (market, credit, liquidity, etc.), Risk assessment and measurement techniques, Risk management strategies and tools

Capital Budgeting and Investment Decisions: Evaluation of investment projects, Capital budgeting techniques (NPV, IRR, payback period)

Financial Planning and Forecasting: Importance of financial planning, Forecasting techniques and methodologies, Budgeting and variance analysis

Green Finance and Sustainable Investing: Introduction to green finance and its significance, Environmental, Social, and Governance (ESG) factors, Sustainable investment strategies and practices

Financial Risk Management: Hedging techniques and derivatives, Portfolio risk management, Stress testing and scenario analysis

Case Studies and Real-World Applications: Analysis of financial risk scenarios, Application of strategic finance principles, Evaluation of green finance initiatives

Emerging Trends in Finance: Technological advancements in finance, Fintech and digital finance innovations, Future outlook and implications for finance professionals

Reference Text Books:

"Corporate Finance" by Stephen A. Ross, Randolph W. Westerfield, and Jeffrey Jaffe.

"Principles of Corporate Finance" by Richard A. Brealey, Stewart C. Myers, and Franklin Allen.

"Green Finance and Investment: Mapping Channels to Mobilize Institutional Investment in Sustainable Energy" by OECD Publishing.

Course Name : Advanced oil and gas drilling, Multilateral and horizontal well technology and production engineering

Course Instructor: Shri. Ghana Gogoi, Former Executive Director, Oil India Ltd.

Shri. Arun Datta, Former Chief Engineer (Production), ONGC

Shri. Basudeb Sarkar, Former Chief GM (Production), ONGC

Objectives: This course focuses on advanced oil and gas drilling and production engineering. Candidates will develop an in-depth understanding of advanced drilling techniques, reservoir evaluation, production optimization, and field development strategies. Topics covered include drilling engineering principles, well design, equipment, well completions, artificial lift methods, and enhanced oil recovery. By the end of the course, candidates will be upgraded with the necessary skills to address complex challenges in oil and gas drilling and production engineering.

Course Contents:

- **Introduction to Advanced Drilling and Production Engineering:** Overview of drilling and production operations, Emerging trends and challenges in the industry
- **Drilling Engineering Principles and Practices:** Drilling fluid properties and selection, Drill bit technology and selection, Wellbore stability and drilling problems, Well control and Fishning Operations
- **Advanced Drilling Techniques:** Introduction of advance drilling Engineering, drilling practices, spudding in, tripping procedures, Observation of hole behaviour during tripping. trip chart.
- **Multilateral and Horizontal Well Planning:** Overview of multilateral and horizontal well systems, Well trajectory design and optimization, Casing and completion design for multilateral and horizontal wells
- **Multilateral and Horizontal Well Execution:** Drilling techniques for multilateral and horizontal wells, Wellbore stability challenges and mitigation strategies, Well control and drilling fluid management in complex well systems
- **Advanced Drilling Fluid Properties:** Functions of Drilling mud. And properties requirement. Effects of various mud properties on wellbore stability. Bit design and selection, BHA design for optimum ROP, Details of Drill pipes. Details of Casing properties and casing accessories.
- **Wellbore Challenges and Remediation Techniques:** Wellbore instability and lost circulation, Remedial techniques for wellbore problems, Hole cleaning and cuttings transport in horizontal wells
- **Well Design and Completions:** Casing and cementing design, Well control and blowout prevention, Wellbore integrity and zonal isolation
- **Well Workover/ Well Maintenance:** Planning and scheduling workover jobs – along with possible gain, types of jobs (cement squeezing, zone isolation etc.), and criticality involved in these operations
- **Production Enhancement and Production Optimization:** Production Enhancement Methods and Optimization Techniques, Artificial lift methods, Well performance analysis, and remedial measures
- **Production logging and well surveillance:** Well flow evaluation and production logging and advanced well monitoring and control
- **Field Development Strategy:** Steps taken for Field Development – Planning, scheduling, evaluation and execution

- **Case Studies and Industry Examples:** Analysis of real-world drilling and production projects, Evaluation of challenges and solutions, Application of learned concepts to industry scenarios

Reference Text books:

"Drilling Engineering" by J.J. Azar and G. Robello Samuel

"Applied Drilling Engineering" by Adam T. Bourgoyne Jr., Keith K. Millheim, and Martin E. Chenevert

"Petroleum Production Engineering" by Boyun Guo, William C. Lyons, and Ali Ghalambor

“Petroleum Engineering Handbook”, Larry W. Lake, Editor-in-Chief, “Vol-IV Production Operations Engineering” Joe Dunn Clegg, Editor

“PEHB Vol-IV – Production Operation Engineering”, Society of Petroleum Engineers

“The Technology of Artificial Lift Methods Vol.4” by Brown K E and Beggs H D

“Production Optimization Using Nodal Analysis”, Dale Beggs, 2003, OGCI Publications

“Surface Production Operations”, Ken Arnold Gulf Publishing Company, Houston, Texas

“Petroleum Economics and Engineering”, Hussein K. Abdel-Aal

Course Name : Reservoir modeling and simulation: Reserve estimation, EOR Techniques, Cap Rock Analysis and integrated reservoir management

Course Instructor: Shri. Sidhartha Sur, Former Executive Director, Former Head: Institute of Reservoir Studies, ONGC

Dr. Vamegh Rasouli, Professor & HOD, Department of Energy and Petroleum Engineering, University of Wyoming, United States of America

Shri. R K Dhasmana, Former Executive Director and Basin Manager KG Basin, ONGC; EdTech Director, Zemblance Hydrocarbons

Objectives: The objective of this course is to provide candidates with advanced knowledge and skills in reservoir modeling and simulation, with a focus on reserve estimation and cap rock analysis. Participants will learn to apply modeling techniques to estimate hydrocarbon reserves and analyze the integrity and effectiveness of cap rock formations. This course focuses on the advanced techniques and field applications of enhanced oil recovery (EOR) methods in the oil and gas industry. Students will gain a deeper understanding of reservoir characterization, EOR selection criteria, and the practical implementation of various EOR techniques.

Course Contents:

- **Reservoir Characterization and Data Acquisition:** Well logging and core analysis for reservoir characterization, Reservoir fluid sampling and analysis techniques, Integration of geological and geophysical data for reservoir modeling
- **Reserve Estimation and Uncertainty Analysis:** Deterministic and probabilistic methods for reserve estimation, Monte Carlo simulation for uncertainty analysis, Risk and decision analysis in reserve estimation
- **Reservoir Modeling Workflows:** Grid construction and discretization techniques, Upscaling and downscaling for dynamic reservoir simulation, Model initialization and boundary condition specification
- **Reservoir Simulation Techniques:** Finite difference and finite element methods, Numerical solution of flow equations, Handling of compositional and thermal effects in simulation
- **Cap Rock Analysis and Integrity Assessment:** Mechanical and petrophysical properties of cap rocks, Sealing capacity and failure mechanisms, Analysis of cap rock integrity for hydrocarbon containment
- **Case Studies and Industry Applications:** Analysis of reservoir modeling and simulation case studies, Application of cap rock analysis in practical scenarios
- **Introduction to Enhanced Oil Recovery (EOR):** Overview of EOR methods and their significance in the industry, Reservoir characteristics and challenges for EOR implementation
- **Case Studies and Industry Best Practices:** Analysis of successful EOR field applications, Lessons learned and key takeaways from EOR projects, Emerging trends and technologies in EOR field applications

Reference Text books:

"Enhanced Oil Recovery: Field Planning and Development Strategies" by Vladimir Alvarado and G. Paul Willhite

"Practical Enhanced Reservoir Engineering: Assisted with Simulation Software" by Abdus Satter and Ganesh Thakur

"Chemical Enhanced Oil Recovery (cEOR): A Practical Overview" by Laura Romero-Zerón and Eduardo Manrique-Espinoza

Course Name : Underground Coal Gasification & Surface Gasification with Applied Thermodynamics: Methods, Technology, Applications

Course Instructor: Dr. Hari Vuthaluru, Associate Professor, WA School of Mines: Minerals, Energy and Chemical Engineering, Curtin University, Australia

Dr. V. Raghavan, Professor, Department of Mechanical Engineering, IIT Madras

Dr. Rajesh R Nair, Professor, Petroleum Engineering Programme, Department of Ocean Engineering, IIT Madras

Shri. R K Dhasmana, Former Executive Director and Basin Manager KG Basin, ONGC; EdTech Director, Zemblance Hydrocarbons

Objectives: The objective of this course is to provide candidates with a comprehensive understanding of underground coal gasification (UCG) and surface gasification methods, technologies, and their applications. Candidates will learn the principles and techniques involved in converting coal into a gaseous fuel underground or on the surface. The course aims to equip candidates with the knowledge to evaluate the feasibility, environmental impacts, and economic potential of UCG and surface gasification projects.

Course Contents:

- **Introduction to Underground Coal Gasification (UCG):** Principles and advantages of UCG, UCG process and reactions, UCG technology and equipment overview
- **Geology and Geophysical aspects of UCG basins:** Exploration methods and Basin Management
- **Review of Ideal Gas, Ideal gas mixtures and mixing rules:** 3.1 Real gas behavior, 3.2 Real gas equations of state, 3.3 Property relations for mixtures and Psychrometry
- **Geomechanics in UCS:** Wellbore stability, Stress estimation and Subsidence monitoring
- **Applied Thermodynamics:** Combustion: Combustion reactions – Stoichiometry, First law analysis, Heat calculations, Adiabatic flame temperature
- **Surface Gasification Techniques:** Overview of surface gasification methods, Fixed-bed gasification, Fluidized-bed gasification, Entrained-flow gasification
- **UCG and Surface Gasification Process Design:** Gasifier design and operation parameters, Gasification kinetics and thermodynamics, Process optimization and control strategies
- **Environmental Considerations:** Environmental impacts of UCG and surface gasification, Carbon capture and storage (CCS) in gasification projects, Air and water pollution control in gasification processes
- **Economic Feasibility and Applications:** Economic evaluation of UCG and surface gasification projects, Market opportunities and potential applications, Techno-economic analysis and project planning
- **Integration with Energy Systems:** Integration of UCG and surface gasification with power generation, Syngas utilization and downstream processes, Co-production of fuels and chemicals from gasification products
- **Case Studies and Industry Applications:** Analysis of real-world UCG and surface gasification

Reference Text books:

"Underground Coal Gasification and Combustion" by Alexander Y. Klimenko and Vladimir S. Litvinenko

"Coal Gasification and Its Applications" by David A. Bell and Brian F. Towler

"Gasification of Unconventional Feedstocks" by Vivek V. Ranade, Ajay K. Dalai, and Sreekala Bajwa

Course Name : Renewable Energy (Geothermal, Wind, Solar, and Battery), Bio-Fuels: Production, Transportation, Storage, and Application

Course Instructor: Dr. K. Srinivas Reddy, Professor, Department of Mechanical Engineering, IIT Madras
Dr. R K Malhotra, Former Chairman and Director (R&D), IOCL; Professor of Practice, IIT Delhi
Dr. SSV Ramakumar, Director (R&D), IOCL

Objectives: The objective of the course "Renewable Energy (Geothermal, Wind, Solar, and Battery): Technologies, Applications, and Policies" is to provide students with a comprehensive understanding of various renewable energy technologies, including geothermal, wind, solar, and battery storage systems. Students will learn about the principles, design, and practical applications of these technologies in the context of renewable energy generation and sustainability. The course aims to equip students with the knowledge and skills necessary to analyze, evaluate, and implement renewable energy projects and understand the policies and regulations that govern their deployment.

Course Contents:

- **Introduction to Renewable Energy:** Overview of renewable energy sources and their importance, Global energy demand and the need for renewable energy transition, Environmental and sustainability aspects of renewable energy
- **Geothermal Energy:** Geothermal resource assessment and exploration techniques Geothermal power plant design and operation, Case studies of geothermal energy projects
- **Wind Energy:** Wind resource assessment and wind turbine technology, Wind farm design and performance optimization, Case studies of wind energy projects
- **Solar Energy:** Solar radiation principles and solar resource assessment, Photovoltaic (PV) technology and system design, Concentrated solar power (CSP) systems and applications, Case studies of solar energy projects
- **Battery Storage Systems:** Energy storage technologies and their role in renewable energy integration, Battery technologies, performance characteristics, and applications Grid-scale and distributed battery storage systems, Case studies of battery storage projects
- **Biofuels:** Production processes for biodiesel and ethanol, Feedstock selection and availability, Fuel properties and blending considerations, Applications and market trends
- **Synthetic Fuels:** Fischer-Tropsch synthesis for synthetic fuel production, Gas-to-liquids (GTL) technology and applications, Coal-to-liquids (CTL) processes and challenges Environmental impacts and sustainability considerations
- **Feedstock Selection and Processing:** Types of feedstocks for alternative fuel production, Feedstock characteristics and availability, Pre-treatment and refining techniques
- **Policies and Regulations:** Renewable energy policies, targets, and incentives Feed-in tariffs, net metering, and renewable portfolio standards, Regulatory frameworks and permitting processes, Case studies of policy-driven renewable energy markets
- **Project Feasibility and Economics:** Project feasibility assessment and techno-economic analysis, Financial models, incentives, and financing options, Risk assessment and mitigation strategies

Reference Text books:

Kaltschmitt, M., Streicher, W., Wiese, A. (2007). Basics of Renewable Energy Supply. In: Kaltschmitt, M., Streicher, W., Wiese, A. (eds) Renewable Energy.

Robert Ferry, Elizabeth Monoian, 2012. A Field Guide to Renewable Energy Technologies. Society for Cultural Exchange

Syllabus- Module: 2

Course Name: Hydrogen Production: I. Methane steam reforming II. Electrolysis III. Biomass

Course Instructor: Dr. SSV Ramakumar, Director (R&D), IOCL

Dr. R K Malhotra, Former Chairman and Director (R&D), IOCL; Professor of Practice, IIT Delhi

Objectives: The course "Hydrogen Production" aims to provide students with a comprehensive understanding of methane steam reforming, electrolysis, and biomass gasification for hydrogen generation. Students will learn about the principles, mechanisms, and operational aspects of each method. The course focuses on equipping students with the knowledge and skills to analyze, evaluate, and optimize hydrogen production processes for various applications, considering factors such as efficiency, environmental impact, and purification techniques.

Course Contents:

- **Introduction to Hydrogen Production:** Importance and applications of hydrogen as an energy carrier, Overview of methane steam reforming, electrolysis, and biomass gasification
- **Methane Steam Reforming:** Principles and mechanisms of methane steam reforming, Catalysts and reactor design for steam reforming, Process optimization and efficiency improvement, Environmental considerations and carbon capture
- **Electrolysis:** Principles of electrolysis for hydrogen production, Alkaline, proton exchange membrane, and solid oxide electrolysis technologies, Electrolyzer design and operation, Power sources for electrolysis (renewables, grid electricity), Electrolysis efficiency and cost considerations
- **Biomass Gasification:** Biomass gasification for hydrogen production, Thermochemical and biochemical pathways, Feedstock selection and preparation, Gasification reactor types and operation, Gas cleanup and hydrogen purification
- **Efficiency and Environmental Considerations:** Evaluation of hydrogen production efficiency, Environmental impacts and mitigation strategies, Carbon capture and utilization in hydrogen production
- **Purification Techniques:** Purification methods for obtaining high-purity hydrogen, Membrane separation, pressure swing adsorption, and other techniques
- **Applications of Hydrogen:** Hydrogen utilization in transportation, power generation, and industry, Fuel cells and hydrogen storage technologies, Integration of hydrogen into existing energy systems
- **Optimization and Analysis:** Analysis of hydrogen production processes, Evaluation of process efficiency and performance, Optimization techniques for enhanced hydrogen production

Reference Text books:

"Hydrogen Production and Remediation of Carbon and Pollutants" by E.E. Smolinski and S.J. Huang

"Hydrogen Energy: Economic and Social Challenges" by Yi Zhang

"Hydrogen Production: Processes, Technologies, and Economics" by A.S. Gokhale and A.K. Dalai

Course Name : Hydrogen Transportation and Storage

Course Instructor: Dr. SSV Ramakumar, Director (R&D), IOCL

Dr. R K Malhotra, Former Chairman and Director (R&D), IOCL; Professor of Practice, IIT Delhi

Shri. MV Ravi Someswarudu, Former Executive Director (O&M-CO), GAIL (India) Limited

Dr. Manivannan P. V., Associate Professor, Department of Mechanical Engineering, IIT Madras

Objectives: The objective of the course "Hydrogen Transportation and Storage" is to provide students with a comprehensive understanding of the principles, technologies, and challenges related to the transportation and storage of hydrogen. Students will explore various methods, including compression, liquefaction, and hydrogen carriers, as well as safety considerations, infrastructure requirements, and emerging trends in hydrogen transportation and storage.

Course Contents:

- **Introduction to Hydrogen Transportation and Storage:** Importance and challenges of hydrogen transportation and storage, Overview of compression, liquefaction, and hydrogen carrier methods
- **Compression-based Hydrogen Transportation:** Principles and technologies of hydrogen compression, Compressor types and operation, Infrastructure requirements for compressed hydrogen transportation, Safety considerations and standards
- **Liquefaction-based Hydrogen Transportation:** Principles and processes of hydrogen liquefaction, Liquefaction technologies and equipment, Cryogenic storage and transportation systems, Challenges and considerations for liquefied hydrogen
- **Hydrogen Carriers:** Overview of hydrogen carrier technologies (ammonia, liquid organic hydrides, metal hydrides), Carrier synthesis, storage, and release mechanisms, Infrastructure requirements and challenges for hydrogen carriers
- **Safety Considerations in Hydrogen Transportation:** Hazards and risks associated with hydrogen transportation, Safety codes, standards, and regulations, Mitigation strategies and best practices
- **Infrastructure Requirements for Hydrogen Transportation:** Hydrogen refueling stations and distribution networks, Storage facilities and capacity planning, Infrastructure development challenges and opportunities
  Hydrogen Storage Technologies: Cryogenic storage and transportation, Hydrogenation-based storage methods, Solid-state hydrogen storage materials and systems
- **Emerging Trends and Advancements:** Innovations in hydrogen transportation and storage, Hydrogen pipeline systems, Advanced storage technologies and materials

Reference Text books:

"Hydrogen Transport and Storage" by Ram B. Gupta and Angelo Basile

"Hydrogen Infrastructure: Transportation, Storage, and Integration" by Ryan O'Hayre, Suk-Won Cha, Whitney Colella, Fritz B. Prinz

"Hydrogen Energy: Challenges and Prospects" by Bent Sørensen

Course Name : Applied Oil and gas seismic data analysis and advanced interpretation

Course Instructor: Dr. R. David Koilpillai, Qualcomm Institute Chair Professor, Department of Electrical Engineering, IIT Madras

Dr. Rajesh R Nair, Professor, Petroleum Engineering Programme, Department of Ocean Engineering, IIT Madras

Shri. R K Dhasmana, Ex- Executive Director and Basin Manager KG Basin, ONGC; EdTech Director, Zemblance Hydrocarbons

Objectives: The course "Applied Oil and Gas Seismic Data Analysis and Advanced Interpretation" aims to develop students' skills in analyzing seismic data for the purpose of identifying subsurface structures and potential hydrocarbon reservoirs. Students will learn various techniques such as seismic data processing, imaging, attribute analysis, and interpretation workflows. The course will also cover advanced interpretation methods, including seismic stratigraphy, amplitude analysis, and AVO analysis, to enhance reservoir characterization and exploration outcomes.

Course Contents:

- **Introduction to Seismic Data Analysis:** Overview of seismic data acquisition and interpretation, Principles and concepts of seismic data analysis in the oil and gas industry
- **Seismic Data Processing and Imaging:** Data conditioning and noise reduction techniques, Migration methods for accurate imaging of subsurface structures
- **Seismic Attribute Analysis:** Introduction to seismic attributes and their interpretation, Attribute analysis techniques for reservoir characterization
- **Seismic Inversion:** Principles and methods of seismic inversion, Application of seismic inversion for reservoir property estimation
- **Interpretation Workflows:** Workflow design and best practices for seismic interpretation, Integration of well data, geological models, and seismic data for interpretation
- **Seismic Stratigraphy:** Principles and applications of seismic stratigraphy, Identification and characterization of stratigraphic features using seismic data
- **Amplitude Analysis:** Principles of amplitude variation with offset (AVO) analysis, Interpretation of amplitude anomalies and hydrocarbon indicators
- **Advanced Interpretation Techniques:** Seismic inversion for reservoir characterization, Time-lapse seismic interpretation for monitoring reservoir changes
- The course will end with velocity optimization concepts, as well as integration of seismic data and well data in order to generate depth and isochore maps

Reference Text books:

Roy Chowdhury, K. (2011). Seismic Data Acquisition and Processing. In: Gupta, H.K. (eds) Encyclopedia of Solid Earth Geophysics.

"Seismic Data Analysis: Processing, Inversion, and Interpretation of Seismic Data" by Öz Yılmaz

Course Name : Petroleum geomechanics and field applications

Course Instructor: Dr. Rajesh R Nair, Professor, Petroleum Engineering Programme, Department of Ocean Engineering, IIT Madras

Dr. Venkatesh A, IIT Madras Alumni, Geomechanics Researcher, CTO Zemblance

Objectives: The objective of the course "Petroleum Geomechanics and Field Applications" is to provide students with a comprehensive understanding of the principles, theories, and practical applications of geomechanics in the petroleum industry. Students will learn the mechanical behavior of rocks, stress and strain analysis, and their impact on reservoir engineering, wellbore stability, hydraulic fracturing, and production operations. The course aims to equip students with the knowledge and skills necessary to analyze and mitigate geomechanical risks and optimize field operations for safe and efficient petroleum extraction.

Course Contents:

- **Introduction to Petroleum Geomechanics:** Overview of geomechanics in the petroleum industry, Role of geomechanics in wellbore stability, reservoir characterization, and production operations
- **Rock Mechanics Fundamentals:** Mechanical properties of rocks: stress, strain, and deformation, Elasticity, plasticity, and failure criteria of rocks, Laboratory testing techniques for rock characterization
- **Stress and Strain Analysis:** Concepts of stress and strain in rocks, Stress distribution and its effects on reservoir performance, Stress measurement techniques and interpretation
- **Reservoir Geomechanics:** Geomechanical in reservoir characterization, Rock properties and their impact on reservoir behavior, Reservoir stress state analysis and its influence on production operations
- **Wellbore Stability Analysis:** Causes and mechanisms of wellbore instability, Wellbore failure analysis and mitigation strategies, wellbore stability prediction models
- **Hydraulic Fracturing Design and Optimization:** Principles and design of hydraulic fracturing operations, Optimization techniques for maximizing fracturing effectiveness
- **Geomechanics in Production Operations:** Geomechanical in production and reservoir management, Analysis of induced stress changes, Geomechanical aspects of enhanced oil recovery methods
- **Laboratory Testing and Interpretation:** Rock sample preparation and laboratory testing techniques, Interpretation of geomechanical data and parameters, Correlation between laboratory tests and field behavior
- **Field Applications and Case Studies:** Analysis of real-world geomechanical challenges in petroleum operations, Application of learned concepts to case studies

Reference Text books:

Zoback, Mark D. (2010). Reservoir Geomechanics. Cambridge University Press.

Fjar, E., Holt, R. M., Raaen, A. M., Risnes, R., & Horsrud, P. (2008). Petroleum related rock mechanics (Vol. 53). Elsevier.

Course Name : Application of Machine Learning (ML) and Artificial Intelligence (AI) in the Oil and Gas Industry

Course Instructor: Dr. Minou Rabiei, Associate Professor, Department of Energy and Petroleum Engineering, University of Wyoming, United States of America

Dr. Chandra Shekar L, Assistant Professor, Department of Computer Science &Engineering IIT Madras

Dr. Kalyanaraman Venugopal, Associate Research Scientist, Department of Energy and Petroleum Engineering, University of Wyoming, United States of America

Objectives: The course "Application of ML and AI in Digital Oil and Gas" aims to provide students with a comprehensive understanding of how ML and AI technologies are used in the oil and gas industry. Students will learn to apply ML and AI algorithms for data analysis, predictive modeling, optimization, and automation in various aspects of the industry. The course will cover topics such as reservoir characterization, production optimization, predictive maintenance, and safety monitoring, along with the associated challenges and ethical considerations.

Understand the fundamental concepts of machine learning and artificial intelligence in the context of the oil and gas industry. Gain knowledge of various ML and AI techniques and algorithms commonly used in digital oil and gas applications. Learn how to preprocess and analyze large-scale oil and gas data sets to extract valuable insights. Develop skills in building ML and AI models for predictive modeling, optimization, and automation in oil and gas operations. Understand the challenges, limitations.

Course Contents:

- **Introduction to ML and AI in the Oil and Gas Industry:** Overview of ML and AI technologies and their applications, Digital transformation and its impact on the oil and gas sector
- **Data Preprocessing and Feature Engineering:** Data cleaning, integration, and transformation techniques, Feature selection and engineering for oil and gas data
- **ML Algorithms and Techniques:** Supervised, unsupervised, and reinforcement learning algorithms; Regression, classification, clustering, and anomaly detection techniques
- **Predictive Modeling in Oil and Gas:** Time-series analysis and forecasting, Reservoir performance prediction and optimization
- **Optimization Techniques:** Linear and nonlinear optimization algorithms, Production scheduling and supply chain optimization
- **AI-driven Automation in Oil and Gas:** Robotics, process automation, and intelligent systems, Autonomous drilling, production, and inspection technologies
- **Challenges and Ethical Considerations in ML and AI:** Bias, fairness, and transparency in ML and AI applications, Data privacy and security concerns
- **Case Studies and Best Practices:** Real-world applications of ML and AI in the oil and gas industry, Industry trends and emerging technologies

Reference Text books: "Machine Learning in the Oil and Gas Industry: A Primer" by Ahmed Hashmi and M. Rehan Chaudhry

"Artificial Intelligence in the Oil and Gas Industry: Transforming the Future" by Cesar Sciammarella and Moustafa Gouda