AMET
ACADEMY OF MARITIME EDUCATION AND TRAINING
DEEMED TO BE UNIVERSITY
(Under Section 3 of UGC Act 1956)

Open Elective courses of 6th Semester

S.NO	Department	Open Elective courses
1.	Department of EEE	Solar Energy systems
2.	Department of Mechanical Engineering	Non Destructive Testing
3.	AMET Business School	Organizational Development
4.	Department of Naval Architecture and Offshore Engineering	Basic Principles of Marine Vessel Design
5.	Department of Marine Biotechnology	Marine Pollution and Biological Solutions
6.	Department of Petroleum Engineering	Offshore Oil & Gas Operations
7.	Department of Mining Engineering	Remote Sensing for Natural Resources
8.	Department of Food Processing Technology	Ready to eat Food Processing Technology
9.	Department of Information Technology	Python Programming
10.	Department of Mathematics	Numerical Methods and Statistic
11.	Department of Physics	Introduction to Nano Science
12.	Department of Chemistry	Marine Chemistry

PROGRAM	Common to all the BE Programmes offered in AMET (ME, Mech, EEEM, PE, HE, NA &OE, Mining) and B.Tech FPT; BBA Shipping, B.Com., LCA					
Course Code UEEEO08	Course Name: Solar Energy Systems		**L**	**T**	**P**	**C**
			3	0	0	3
Year / Semester	III Year / VI Semester		Contact hours per week (3 Hrs)			
Prerequisite course	NIL					
Course category	**Humanities and Social Sciences**	**Management courses**	**Professional Core**		**Professional Elective**	
	Basic Science	**Engineering Science**	**Open Elective**		**Mandatory**	
			√			
Introduction	Introduction to the course Class policies, grades, homework, prerequisites, and other details Power generation Overview of the power industry in the US today Fuels, heat rates Generation types Wind generation.					
Course Objective	1. To familiarize with the characteristics of solar radiation, its global distribution, and conversion methods of solar energy to heat and power. 2. To familiarize with the concepts of control and drives, importance of embedded system and implementation of control system for solar energy applications.					
Course Outcome	The Students will be able to 1. Illustrate the overview of solar resources 2. Explain the solar radiation and measurement techniques 3. Demonstrate how to calculate solar radiation at a given location 4. Summarize how to model a solar power system using MATLAB. 5. Outline the principle of operation of solar plants. 6. Apply the concept of solar collectors to renewable energy systems.					

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	2	-	-	-	-	-	-	-
CO2	2	2	3	-	2	-	-	-	-	-	2	2
CO3	2	3	2	3	2	-	-	-	-	-	2	2
CO4	3	2	3	3	3	-	-	-	-	-	2	2
CO5	2	3	3	2	3	-	-	-	-	-	2	2
CO6	3	3	3	3	3	-	-	-	-	-	2	3
AVERAGE	2.5	2.7	2.7	2.8	2.5	-	-	-	-	-	2	2
CORRELATION LEVELS				1. SLIGHT (LOW)				2. MODERATE (MEDIUM)				

UNIT I : ENERGY RESOURCES AND SOLAR SPECTRUM **9 Hrs**

World energy resources - Indian energy scenario - Environmental aspects of energy utilization. Renewable energy resources and their importance - Global solar resources. Solar spectrum – Electromagnetic spectrum, basic laws of radiation. Physics of the Sun - Energy balance of the earth, energy flux, solar constant for earth, greenhouse effect.

UNIT II : SOLAR ELECTRICAL ENERGY CONVERSION **9 Hrs**

Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants.

UNIT III : MODEL REPRESENTATION **9 Hrs**

Introduction to MATLAB, matrix operation, different graphical output, integration and solution to differential equation. Types of error - Convergence and stability. Models of electro - mechanical system – Thermo - fluid systems, solar photo voltaic cell and DC motor. Transient and steady state response of system. Simulation of model using MATLAB.

UNIT IV : CONTROL OF SOLAR PLANTS **9 Hrs**

Basic and Advanced control of solar plants - basic control algorithms, adaptive and optimal controls. Model based predictive control strategies, frequency domain control and robust optimal control.

UNIT V : APPLICATIONS OF SOLAR COLLECTORS **9 Hrs**

Application of non-concentrating collectors in low temperature solar thermal plants for space heating and cooling, drying, seawater desalination. Use of concentrating collectors for process heat production and power generation- Mini project of solar PV and its applications

TOTAL: 45 PERIODS

TEXT BOOKS :

1. Eduardo F. Camacho, Manuel Berenguel, Francisco R. Rubio, Diego Martinez,“Control of Solar Energy Systems”, Springer, 2012.
2. Kai Velten., “Mathematical Modeling and Simulation”, 1st ed., Wiley-VCH, 2009
3. Artur V.Kilian, “Solar Collectors: Energy Conservation, Design and Applications”,Nova Science Publishers Incorporated, 2009

REFERENCES :

1. Garg .H.P, Prakash .J, “Solar Energy Fundamentals and Applications”, TataMcGraw-Hill, 2005.
2. Kalogirou .S, “Solar Energy Engineering”, Processes and Systems, Elsevier,2009.
3. Tiwari .G.N, “Solar energy: Fundamentals, Design, Modeling & Applications”,CRC Press Inc., 2002.

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DEPARTMENT OF MECHANICAL ENGINEERING
CBCS CURRICULUM (2017-2018) (Regulation D)

Course Code	Course Name		L	T	P	C
UDMCO05	**NON DESTRUCTIVE TESTING**		**3**	**0**	**0**	**3**
(Common to All Engineering Courses)						
Year and Sem	**III/VI**	Course Type	Open Elective Course			
Prerequisite Course		Contact Hours per Week	3			
Course Objective	1	To learn about NDET and surface NDT techniques				
	2	To understand about radio graphic testing				
	3	To learn about eddy current testing and ultrasonic testing				
	4	To understand the concept of special/emerging testing				
	5	To learn about the defects in materials				

Course Outcome	1	After completing this course, the students will be able to understand the NDT techniques for various products.
	2	They will be able to know skills needed for selection of appropriate NDT technique(s) for new inspection jobs
	3	The students will be able to acquire sound knowledge of established NDE techniques and basic familiarity of emerging NDE techniques.
	4	They will be able to know the use of standards and codes in the area of NDET
	5	They will be able to identify the defects in materials

UNIT I INTRODUCTION TO NDET AND SURFACE NDT TECHNIQUES

Introduction to non-destructive testing and evaluation, visual examination, liquid penetrant testing and magnetic particle testing. Advantages and limitations of each of these techniques.

UNIT II RADIOGRAPHIC TESTING

Radiography principle, electromagnetic radiation sources, X-ray films, exposure, penetrameter, radiographic imaging, inspection standards and techniques, neutron radiography. Radiography applications, limitations and safety.

Document Prepared in "Board of Studies" held on	Document Approved in "Academic Council" held on
Date : 15.05.2018 .	Date : 31.05.2018 .

UNIT III EDDY CURRENT TESTING AND ULTRASONIC TESTING

Eddy current principle, depth of penetration, eddy current response, eddy current instrumentation, probe configuration, applications and limitations. Properties of sound beam, ultrasonic transducers, inspection methods, flaw characterization technique, immersion testing.

UNIT IV SPECIAL/EMERGING TECHNIQUES

Leak testing, Acoustic Emission testing, Holography, Thermography, Magnetic Resonance Imaging, Magnetic Barkhausen Effect. In-situ metallography.

UNIT V DEFECTS IN MATERIALS / PRODUCTS AND SELECTION OF NDET METHODS

Study of defects in castings, weldments, forgings, rolled products etc. and defects arising during service. Selection of NDET methods to evaluate them. Standards and codes.

Text Books

1. Baldevraj, Jayakumar T., Thavasimuthu M., (2008) "Practical Non-Destructive Testing", 3rd edition, Narosa Publishers.

Reference Books

1. American Society for Metals, "Non-Destructive Evaluation and Quality Control": Metals Hand Book: 1992, Vol. 17, 9th Ed, Metals Park, OH.
2. Paul E Mix, "Introduction to nondestructive testing: a training guide", Wiley, 2nd edition New Jersey, 2005.
3 . Ravi Prakash, "Nondestructive Testing Techniques", New Age International Publishers, 1st rev. edition, 2010.

PROGRAM	ABS UG – OPEN ELECTIVE				
Course Code UDBSO07	**Course Name : Organizational Development**	**L**	**T**	**P**	**C**
		3	0	0	3
Year and Semester	III (VI Semester)	Contact hours per week (3Hrs)			
Prerequisite course	NIL				

Course category	**Humanities and Social Sciences**	**Management courses**	**Professional Core**	**Professional Elective**
	Basic Science	**Engineering Science**	**Open Elective**	**Mandatory**
			✓	

Course Objective	1. To learn the basics of organizational development 2. To study the issues and challenges for organizational development 3. To understand the innovative changes for organizations 4. To study about change management 5. To study about change management for effective organizational management,
Course Outcome	The Students will be able to 1. Make use of characteristics of Organizational development as managers. 2. Examine the theories and models of Organizational change . 3. Adapt ethical values in resolving ethical dilemma. 4. Explain the process and challenges of human resource intervention. 5. Evaluate the future scope of organizational development in the globalized environment. 6. Appraise the theories and models in the business context

Pos/ COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	1	2	2	2	3	3	3	2	2	3
CO2	-	-	3	3	3	-	2	3	-	3	2
CO3	2	3	3	3	3	2	3	3	2	3	3
CO4	3	3	3	3	3	-	3	3	2	3	3
CO5	2	2	2	3	3	3	3	3	2	3	3
CO6	3	2	3	3	3	2	3	3	3	3	3
Average	2.4	2.2	2.67	3	2.83	2.5	2.83	3	2.2	2.83	2.83
Correlation Levels		**1. Slight (Low)**			**2. Moderate (Medium)**			**3. Substantial (High)**			

Unit 1:Organisational development **9 hours**

An introduction: Organisational Development – Meaning and Definition, History of OD, Relevance of Organisational Development for Managers, Characteristics of OD, Assumptions of OD

Unit 2:Change Process and Models **9 hours**

Organisational Change, Strategies for Change, Theories of Planned Change (Lewin's change model, Action research model, the positive model), Action Research as a Process, Resistance to Change

Unit 3 : Values and Ethics in OD **9 hours**

Professional Values, Value Conflict and Dilemma, OD Values and Changing Themes over Time, Ethics in OD, Ethical Dilemmas in Practicing OD, Factors that Influence Ethical Judgment

Unit 4 : Human Resource Interventions **9 hours**

HRM Interventions, Goal Setting, Performance Appraisal, Reward Systems, Career Planning and Development, Managing Workforce Diversity, Employee Wellness

Unit 5 : Future of OD **9 hours**

Organisational Development and Globalization, Emerging Trends in OD - Expanding the use of OD, Combining traditional "hard" business competencies and OD, Creating whole system change, Using OD to facilitate partnerships and alliances, Enhancing constant learning, Trends within the Organization

Total 45 hours

TEXT BOOK :

Organisational development and change, 10th edition, by Thomas G. Cummings (Author), Christopher G. Worley (Author)

Reference book:

Organisational Development and Intervention Strategies (English, Paperback, S. B. Sharan) 2015

DEPARTMENT OF NAVAL ARCHITECTURE AND OFFSHORE ENGINEERING

PROGRAM	BE-Naval Architecture & Offshore Engineering				
Course Code: UDNAO01	BASIC PRINCIPLES OF MARINE VESSEL DESIGN	**L**	**T**	**P**	**C**
		3	0	0	3
Year and Semester	III Year (semester VI)	Contact hours per week (3Hrs)			
Prerequisite course	NIL				
Course category	**Humanities and Social Sciences**	**Management courses**	**Professional Core**	**Professional Elective**	
	Basic Science	**Engineering Science**	**Open Elective**	**Mandatory**	
			✓		
Course Objective	1. To understand the various steps involved in ship design. 2. This course provides basic knowledge about marine environment. 3. To provide the idea about the ship hull 4. To understand the stability of marine vehicles.				
Course Outcome	1.Understand Marine Environment 2.Understand the design process of a Marine Vessel Design 3.Understand the stability of floating structure 4.Predict the ship resistance and powering 5.Understand ship motions and hull form design 6.Understand the marine vehicle structural design philosophy				

POS/COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	-	1	-	-	1	1	2	2	1	1	2	2
CO2	2	2	2	-	1	-	-	1	1	2	2	1	1	2	2
CO3	2	2	2	-	1	-	-	1	2	2	2	1	1	2	2
CO4	2	2	2	-	1	-	-	1	2	2	2	1	1	2	2
CO5	2	2	2	-	1	-	-	1	2	2	2	1	1	2	2
CO6	2	2	1	-	1	-	-	1	2	2	2	1	1	2	2
AVERAGE	2	2	1.8	-	1	-	-	1	1.7	2	2	1	1	2	2

CORRELATION LEVELS	1.SLIGHT(LOW)	2.MODERATE(MEDIUM)	3.SUBSTANTIAL(HIGH)

UNIT I - MARINE ENVIRONMENT

Ocean Waves, Regular waves, Irregular waves, Beaufort scale, Sea state conditions – Ocean data collection

UNIT II – DESIGN PROCESS

Market Study, Mission requirement, , Identifying the customer needs, System design, System Integration, Design process, Design spiral, Design Stages, Vehicle parameter estimation

UNIT III – STABILITY OF MARINE VESSELS

Hydrostatics, Intact stability, Initial stability, Stability at large angles, Trim, Damage Stability

UNIT IV – HYDRODYNAMIC DESIGN

Ship Resistance components, Estimation of ship resistance, Propulsion characteristics, Ship powering, model tests, Ship Motions, Ship maneuvering, Hullform design

UNIT V - STRUCTURAL DESIGN

Ship building materials, Ship structural components and scantlings, Midship section design, Longitudinal strength, Typical midship sections of bulk carrier, oiltanker and container ships

TEXT BOOKS

1. Ship Design Methodologies of Preliminary Design by ApostolosPapanikolaou
2. Practical Ship Design by D.G.M Watson
3. Ship Design for Efficiency and EconomybyH. Schneekluth and V. Bertram
4. Ship Design and Construction by R.Taggart

REFERENCES

1. Basic Ship Theory, Vol.1 & 2 by K.J.Rawson and E.C.Tupper
2. Principles of Naval Architecture, Vol. 1,2&3 by Ed.V. Lewis

Designed by	" Department of Naval Architecture & Offshore Engineering"

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Department of Marine Biotechnology

Open Elective Courses – Even Semester 2020

PROGRAM	B.E. /BTech/BBA/BCom				
Course Code PFBTO05	Course Name : **Marine pollution and biological solutions**	**L**	**T**	**P**	**C**
		3	0	0	3

Year and Semester	III year and VII Semester	Contact hours per week (3Hrs)		
Prerequisite course	Any under graduate degree with Engineering background			
Course category	**Humanities and Social Sciences**	**Management courses**	**Professional Core**	**Professional Elective**
	Basic Science	**Engineering Science**	**Open Elective**	**Mandatory**
			✓	
Course Objective	• To understand the most complex problems of Marine pollution. There can be several causes of ocean pollution, but the leading causes include sewage, toxic chemicals from industries, nuclear waste, thermal pollution, plastics, acid rain, and oil spillage. • This course would provide insight into various types of marine pollution and how they can be managed by biological solutions.			
Course Outcome	At the end of the course the student will be able to :			
	1.	List out the types and sources of marine pollution.		
	2.	Explain about the causes and impacts of marine pollution.		
	3.	Classify the bioindicators used for environmental monitoring.		
	4.	To extend the knowledge for disposal of marine pollutants.		
	5.	Outline the importance of living organisms in the management of marine pollution.		
	6.	Outline the impact of marine pollution in management aspects.		

POS/ COS	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	1	2	2	2	1	2	1	-	-	-	-
CO2	2	2	1	2	1	2	1	-	-	-	-
CO3	1	1	1	1	1	1	1	-	-	-	-
CO4	1	1	2	2	1	2	1	-	-	-	-
CO5	2	2	1	2	2	2	2	-	-	-	-
CO6	1	1	2	2	2	1	1	-	-	-	-
Average	1.3	1.5	1.5	1.8	1.3	1.7	1.2	-	-	-	-
CORRELATION LEVELS			1. SLIGHT (LOW)			**2.** MODERATE (MEDIUM),			**3.** SUBSTANTIAL (HIGH)		

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Department of Marine Biotechnology

Open Elective Courses – Even Semester 2020

Unit - I- Types of Marine Pollution

Marine Pollution-definition- role of GESAMP- major pollutant- sources, transport path, dynamics. Toxicology- lethal and sub lethal effects of pollutants to marine organisms- bioconcentration, bioaccumulation and biomagnifications- methods of toxicity testing factors influencing toxicity- synergistic and antagonistic effects- role of microcosms and mesocosms.

Unit-II- Causes and impacts of Marine Pollution

Analysis and presentation of physical, chemical and biological impacts of aquaculture activities in the coastal environment. Economic impacts of pollution, Global warming and ocean acidification, Marine animal diseases, Marine plant and coral disease's impact on the marine environment. Plastics and Litter source and impact in the marine environment.

Unit - III- Bioindicators of marine pollution

Environmental monitoring- Diversity of bioindicators used for environmental monitoring- biomarkers of marine contamination- Microbial Bioindicators.

Unit - IV- Coastal Zone Management

Knowledge of the precautions - prevent pollution of the marine environment- Knowledge of the use and operation of anti-pollution equipment Knowledge of the approved methods for disposal of marine pollutants.

Unit - V -Management of Marine Pollution with living organisms and their products/processes

Enrichment and isolation of crude oil degrading marine bacteria- Isolation of biosurfactant producing microorganisms- Isolation of selenite/tellurite resistant marine-derived bacteria/fungi for application in bioremediation.

TEXT BOOKS

1. Clark, R.B., 2001. Marine Pollution, Oxford University Press
2. Johnston, R. (ed), 1976. Marine Pollution, Academic Press, London
3. Belkin, S and Cowell, R. R., Ocean & Health: Pathogens of the Marine Environment, Springer Publishers.
4. Satyanarayana, T., Johri, B. and Anil, T., Microorganisms in Environmental Management, Springer Publishers.
5. Reddy, S. M., Charya, M. A. S. and Girisham, S., Microbial Diversity: Exploration and Bioprospecting, Scientific blishers.

<table>
<tr><td>PROGRAM</td><td colspan="5">B.E. Petroleum Engineering</td></tr>
<tr><td>Course Code

UDPEO05</td><td>Course Name :

Offshore Oil & Gas Operations</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td></td><td></td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Year and Semester</td><td>III Year & VI Semester</td><td colspan="4" rowspan="2">Contact hours per week

(3 Hrs)</td></tr>
<tr><td>Prerequisite course</td><td>NIL</td></tr>
<tr><td rowspan="4">Course category</td><td>Humanities and Social Sciences</td><td>Management courses</td><td>Professional Core</td><td colspan="2">Professional Elective</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Basic Science</td><td>Engineering Science</td><td>Open Elective</td><td colspan="2">Mandatory</td></tr>
<tr><td></td><td></td><td>✓</td><td colspan="2"></td></tr>
<tr><td>Course Objective</td><td colspan="5">1. To understand the basics of offshore structures

2. Types and classification of offshore structures

3. Installing offshore structures

4. Understanding drilling and production

5. Estimating the oil resources</td></tr>
<tr><td rowspan="3">Course Outcome</td><td colspan="5">At the end of the course, the Students will be able to</td></tr>
<tr><td>1</td><td colspan="4">Explain the Offshore oil and gas operations</td></tr>
<tr><td>2</td><td colspan="4">Classification, properties of marine sediments</td></tr>
</table>

	3	Describe about the Drilling. Sampling techniques
	4	Analyze offshore structures
	5	Explain drilling components especially for offshore
	6	Illustrate about the Offshore soil mechanics

POS/ COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3									3	2	
CO2	3	2	3	3									2	2	
CO3	2	2	2	2									2	3	3
CO4	1	2	2	1									3	2	1
CO5	1	1	1	1									1	1	
CO6	1	1	1	1									1	1	
Average	1.833333	1.833333	2	1.833333									2	1.83333	2

Correlation Levels	1.Slight(Low)	2.Moderate(Medium)	3.Substantial(High)

KL-Knowledge Level:K1-Remember,K2--Understand,K3-Apply,K4-Analyse,K5-Evaluate,K6-Create : PO-Programe Outcome: CO-Course Outcome :PSO-Programe Specific Outcome

UNIT-I **Introduction (9 Hrs)**

Introduction to offshore oil and gas operations.. Sea States and Weather, Offshore Fixed and mobile Units, Offshore Drilling, Difference in drilling from land, from fixed platform, jack up, ships and semi submersibles. Offshore Well Completion, Offshore Production systems, Deep-water technology, Divers and Safety, Offshore Environment.

UNIT-II **Properties of marine sediments (9 Hrs)**

Introduction; classification, properties of marine sediments. Consolidation and shear strength characteristics of marine sediments. Planning and site exploration.

UNIT-III **Sampling techniques (9 Hrs)**

Drilling. Sampling techniques. Laboratory testing, In situ testing methods and geophysical methods. Current design practices of pile supported and gravity offshore structures.

UNIT-IV **Dynamic analysis of offshore structures (9 Hrs)**

Dynamic analysis of offshore structures. Centrifugal modeling. Anchor design. Break out resistance analysis and geotechnical aspects of offshore pipeline and cable design. Field instrumentation and performance observation.

UNIT-V Offshore soil mechanics (9Hrs)

Offshore soil mechanics; Offshore pile foundations and caissons; Design of breakwaters; Buoy design and mooring systems; Offshore drilling systems and types of platforms; Ocean mining and energy systems.ROV. Onshore drilling-on shore oil rigs, onshore drilling equipments-onshore rig structures-hydraulics applied in onshore rigs.

Total Hours: 45

Text Book

1. Mohamed El-Reedy, Offshore Structures Design, Construction and Maintenance,2012,Gulf Publishers.
1. Sahay.B, Wellsite Geological Techniques for petroleum Exploration

1998,Oxford & IBH Publishing Company

Reference Books

1. BencGerwick Jr.: Construction of Marine and offshore structures, IDT ONGC Dehradun, drilling operations manual,2007

Designed by	" Department of Petroleum Engineering"

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SYLLABUS FOR UNDER GRADUATE IN ENGINEERING AND TECHNOLOGY
B.E – MINING ENGINEERING
ACADEMIC YEAR 2019-2023 (BATCH - IV)

<table>
<tr><td>PROGRAM</td><td colspan="5">BE- Mining Engineering</td></tr>
<tr><td rowspan="2">Course Code:
UDMNO08</td><td rowspan="2">COURSE NAME:
REMOTE SENSING FOR NATURAL RESOURCES</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Year and Semester</td><td colspan="2">III Year (VI SEMESTER)</td><td colspan="3" rowspan="2">Contact hours per week
(3Hrs)</td></tr>
<tr><td>Prerequisite course</td><td colspan="2">NIL</td></tr>
<tr><td rowspan="4">Course category</td><td>Humanities and Social Sciences</td><td>Management courses</td><td>Professional Core</td><td colspan="2">Professional Elective</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Basic Science</td><td>Engineering Science</td><td>Open Elective</td><td colspan="2">Mandatory</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Course Objective</td><td colspan="5">1. To provide exposure to students in gaining knowledge on concepts and applications leading to modeling of earth resources management using Remote Sensing
2. To acquire skills in storing, managing digital data for planning and development.
3. To acquire skills in advance techniques such as hyper spectral, thermal and LiDAR scanning for mapping, modeling and monitoring.
4. To acquire knowledge about mineral corridor and mining information system.
5. To elaborately study about planning in transportation.</td></tr>
<tr><td>Course Outcome</td><td colspan="5">At the end of the course the student will be able to:
1. Discuss the concepts, methodologies and applications of Remote Sensing Technology.
2. Prepare the candidates for National and Global Employability
3. Explain handling instruments, tools, techniques and modeling while using Remote Sensing Technology
4. Discuss theEmpowers the candidate with confidence and leadership qualities.
5. Explain Mining Information system and its utility
6. Explain Transport planning using GPS</td></tr>
</table>

POS/ COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2		3		1				1	1	3		2
CO2	2	2		2		1		2		1			3		
CO3	2		1		3				1			2	3		2
CO4	2			2							1		3		
CO5	3				3				1			1	3		2

SYLLABUS FOR UNDER GRADUATE IN ENGINEERING AND TECHNOLOGY
B.E – MINING ENGINEERING
ACADEMIC YEAR 2019-2023 (BATCH - IV)

CO6															
Average	2.00	0.50	0.50	0.67	1.50	0.17	0.17	0.33	0.33	0.17	0.33	0.67	2.50	0.00	1.00
Correlation Levels				1.Slight(Low)				2.Moderate(Medium)				3.Substantial(High)			

KL-Knowledge Level:K1-Remember, K2—Understand ,K3-Apply, K4-Analyse, K5-Evaluate, K6-Create ;
PO-Programme Outcome; CO-Course Outcome ;PSO-Programme Specific Outcome

UNIT I: Introduction **(9 Hrs)**

Introduction to Remote Sensing, Mineral , structural, geomorphic Anomaly Mapping, Resource Estimation

UNIT II: Survey of mines **(9 Hrs)**

Remote Sensing survey for Mine planning, Mine Monitoring, Identification of Illegal mining and Mining environmental Mapping and monitoring.

UNIT III : GIS **(9 Hrs)**

Creation of Mining maps thru GIS, creation of resource analysis thru GIS software. Systematic retrieval, updation and Modification of mine plans and sections.

UNIT IV : Mineral Corridor **(9 Hrs)**

Mining Information system and its utility, introduction to Mineral Corridor.

UNIT V : Transportation Planning **(9 Hrs)**

Transport planning, effective mine productivity MIS system creation through information and communication systems; ICT Linking of various intra and inter mining companies, central repository system

Total :(45 Hrs)

TEXT BOOKS

1. Satheesh Gopi, Rasathishkumar, N.Madhu, – Advanced Surveying, Total Station GPS and Remote Sensing – Pearson education , 2007 ISBN: 978-81317 00679 52.
2. Alfred Leick, GPS satellite surveying, John Wiley & Sons Inc., 3rd Edition, 2004.
3. Jie Shan and Charles K. Toth, Topographic Laser Ranging and Scanning – Principles and Processing, CRC Press, Taylor & Francis Group, 2009.

REFERENCES:

1. Rueger, J.M. Electronic Distance Measurement, Springer-Verlag, Berlin, 1996.
2. Michael Renslow, Manual of Airborne Topographic LiDAR, The American Society for Photogrammetry and Remote Sensing , 2013.
3. R.Subramanian, Surveying and Levelling, Oxford University Press, Second Edition, 2012.

PROGRAM CODE:UGA007	B.Tech Food Processing Technology				
Course Code: UDFPO08	Ready to Eat Food Processing Technology	L	T	P	C
		3	0	0	3

Year and Semester	III Year (6th Semester)	Contact hours per week (3Hrs)		
Prerequisite course	NIL			
Course category	**Humanities and Social Sciences**	**Management courses**	**Professional Core**	**Professional Elective**
	Basic Science	**Engineering Science**	**Open Elective**	**Mandatory**
			√	

Course Objective	1. To list various processing aspects involved in production of ready to eat foods 2. To understand various RTE products and its importance 3. To Learn processing of Ready to Eat 4. To discover the pros and cons of RTE foods
Course Outcome	After completion of the course, the students will be able to 1. Analyse various RTE foods available. 2. Examine on various processing aspects involved in RTE foods. 3. List the RTE products of cereals 4. List and define the RTE products of dairy, meat and fruits 5. Analyze the SOP's of RTE foods 6. Define the quality standards

POS/COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	2	3	-	-	-	-	1	-	-	-
CO2	-	2	1	-	2	3	-	1	-	-	-	-	-	-	-
CO3	1	-	2	3	-	2	-	-	2	-	-	-	-	-	-
CO4	2	-	2	-	2	2	1	-	-	-	-	-	-	-	-
CO5	-	3	2	-	1	2	-	3	-	-	-	-	-	-	-
CO6	3	2	-	2	2	-	1	-	-	-	-	2	-	-	-
AVERAGE	2.6	2.2	1.6	2.3	2.3	2.5	1.6	2	-	-	-	1.5	-	-	-

CORRELATION LEVELS	1.SLIGHT(LOW)	2.MODERATE(MEDIUM)	3.SUBSTANTIAL(HIGH)

UNITI Introduction **(9 Hours)**

Introduction – definition – need for RTE foods – pros and cons of RTE – recent RTE foods available in market. source of contamination- Microbial concern – – microbial aspects – bacteria, virus, fungi – chemical contamination – physical contamination

UNIT II **Fruis And Vegetables** **(9 Hours)**

Ready to eat fruits and vegetable products – dehydrated fruits and vegetables, pickle, salads, chutney, sauce, ketcup, concentrated curry, dried fruits and vegetables – steaks and chips, cured fruits and vegetables.

UNIT III **Cereals** **(9 Hours)**

Ready to eat cereal products – breakfast cereals from corn, wheat, rice, oats and millets - flaked cereal, puffed cereal, shredded cereal, extruded expanded cereal – noodles, pasta, etc

UNIT IV **Milk Products** **(9 Hours)**

Ready to eat milk products – gulabjammun, peda, ice cream, yogurt, whey drinks, paneer and dairy based sweets.

UNIT V **Meat Products** **(9 Hours)**

Ready to eat meat products – pepperoni – sausages - meat balls – frankfurters- meat pickles.

Text Book

1. Chakraverty, A. 1988. Postharvest Technology of Cereals, Pulses and oilseeds. Oxford and IBH, New Delhi.
2. Kent, N.L. 1983. Technology of Cereals. 3rd Edn. Pergamon Press, Oxford, UK. Mathews, R.H. Ed. 1989. Legumes: Chemistry, Technology and Human Nutrition. Marcel Dekker, New York.

REFERENCES

1. Blanshard J.M.V., Frazier, P.J. and Galliard, T. Ed. 1986. Chemistry and Physics of Baking. Royal Society of Chemistry, London
2. Dauthy, M.E. 1997. Fruit and Vegetable Processing. International Book Distributing Co. Lucknow, India.
3. Jagtiani J., Chan, H.T. and Sakal, W.S. Ed. 1988. Tropical Fruit Processing Academic Press, London.
4. Kadar, A.A. 1992. Postharvest Technology of Horticultural Crops. 2nd Ed. University of California.
5. Lai, G., Siddappa, G. and Tondon G.L. 1986. Preservation of Fruits and Vegetables, Indian Council of Agril. Research, New Delhi
6. Kader, A.A. 1992. Postharvest Technology of Horticultural Crops, 2nd Ed. University of California, Division of Agriculture and National Resources, California.
7. Salunkhe, D.K. and Kadam, S.S. Ed. 1998. Handbook of Vegetable Science and Technology. Marcel Dekker, New York, USA

PROGRAM	Common to Engineering, Management and Commerce			
Course Code UDITO08	Course Name : PYTHON PROGRAMMING	**L**	**T**	**P**	**C**
		3	0	0	3

Year and Semester	III Year (semester VI)		Contact hours per week (3Hrs)	
Prerequisite course	Programming for Problem Solving			
Course category	**Humanities and Social Sciences**	**Management courses**	**Professional Core**	**Professional Elective**
	Basic Science	**Engineering Science**	**Open Elective**	**Mandatory**
			✓	
Course Objective	1. Understand the Preliminary Concepts of Programming Language & syntax and Semantics methods 2. Understand the Strings, Lists, Functions and Methods 3. Write the Sub Python Scripts and the Simple File Programs 4. Handle the Errors &Exceptions 5. Comprehend the OOPs concepts			
Course Outcome	After completion of the course, the students will be able to 1. Write a simple Python program following the basic syntactical structure of Python Language. 2. Develop an application to perform string manipulation 3. Use the built-in function and function objects in the Program 4. Apply Error catching and Exception handling mechanisms 5. Implement file handling in programming environment 6. Apply the OOPS concepts for engineering problems			

POS/COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	2	2	1	-	-	-	-	-	-	-	-	-	-
CO3	2	1	3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	2	1	-	-	-	-	-	-	-	-	-	-
CO5	3	2	2	2	1	-	-	-	-	-	-	-	-	-	-
CO6	2	1	3	3	2	-	-	-	-	-	-	-	-	-	-
AVERAGE	2.5	1.8	2.1	2.1	1.4	-	-	-	-	-	-	-	-	-	-

CORRELATION LEVELS	1.SLIGHT(LOW)	2.MODERATE(MEDIUM)	3.SUBSTANTIAL(HIGH)

UNIT I INTRODUCTION TO PYTHON 9 Hours

Introduction to Python Interpreter and Interactive Mode - Values and Types:Int, Float, Boolean, String and List - Variables - Operators - Expressions - Statements – Comments

UNIT II CONTROL FLOW, FUNCTIONS AND STRINGS 9 Hours

Conditionals: Conditional (If), Alternative (If-Else), Chained Conditional (If-Elif-Else) - Iteration: While, For, Break, Continue, Pass - Functions: Fruitful Functions, Return Values, Parameters, Local and Global Scope, Function Composition and Recursion - Strings: String Slices, Immutability, String Functions and Methods

UNIT III LISTS, TUPLES AND DICTIONARIES 9 Hours

Lists: List Operations, List Slices, List Methods, List Loop, Mutability, Aliasing, Cloning Lists, List Parameters, List Comprehension - Tuples: Tuple Assignment, Tuple as Return Value - Dictionaries: Operations and Methods; Applications: Permutations using list - Telephone directory using dictionary

UNIT IV FILES, EXCEPTION, MODULES AND PACKAGES 9 Hours

Files and Exception: Text Files, Reading and Writing Files, Format Operator and Command Line Arguments - Exception: Errors and Exceptions, Handling Exceptions - Modules –Packages; Applications:Raise an exception if number not quadratic in quadratic equation

UNIT V OOPS CONCEPTS 9 Hours

Class - Objects - methods - Instance - Constructor and Destructor - Friend function - Function Overloading, - Inheritance; Applications:Bank account creation with deposit and withdraw using class

TOTAL HOURS: 45

TEXT BOOKS:

1. John C. Lusth, “The Art and Craft of Programming in Python”, The University of Alabama, 2016
2. PovelSolin, Martin Novak, “Introduction to Python Programming”, NCLab Public Computing, 2013

REFERENCES:

1. Mark Lutz, Learning Python, O’Reilly, Fifth Edition, 2013
2. Jacob Fredslund, Introduction to Python Programming, , 2007
3. Introduction to Python, DaveKuhlman, 2014

PROGRAM	OEC for Semester-IV				
Course Code **UDCMO06**	Course Name : Numerical Methods and Statistics	**L**	**T**	**P**	**C**
		3	0	0	3
Year and Semester	III (VI Semester)	Contact hours per week(3 Hours)			
Prerequisite course	NIL				
Course category	**Humanities and Social Sciences**	**Management courses**	**Professional Core**		**Professional Elective**
	Basic Science	**Engineering Science**	**Open Elective**		**Mandatory**
		✓			
Course Objective	1. To understand the perception of the power of numerical methods 2. To understand numerically different kinds of problems occurring in engineering and technology 3. To understand the basics of approximation, integration and differentiation. 4. To understand how to design experiments and surveys for efficiency. 5. To know the concepts of SQC.				
Course Outcome	The Students will be able to 1. Understand the basic knowledge on solution of polynomials. 2. Use interpolation and approximation to solve engineering problem. 3. Discuss the numerical differenation and integration. 4. Apply to design experiments related Problems 5. Apply the control charts uses in industry 6. Solve problem in engineering field using numerical methods.				

POS\COS	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12
CO1	2	1	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	1	1	-	-	-	-	-	-	-	-	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-
CO6	1	1	-	-	-	-	-	-	-	-	-	-
AVERAGE	**1.67**	**1.5**	-	-	-	-	-	-	-	-	-	-
Correlation level			1.Slight (Low)			2.Moderate(Medium)			3. Substantial (High)			

UNIT I Solution of Equations

9 Hours

Solution of algebraic equations: Fixed point iteration method – Newton Raphson method - Solution of linear system of equations: Iterative methods of Gauss Jacobi and Gauss Seidel.

UNITII Interpolation And Approximation

9 hours

Interpolation with equal intervals: Newton's forward and backward difference formulae. Interpolation with unequal intervals: Lagrange's interpolation – Newton's divided difference.

UNIT III Numerical Differentiation and Integration **9 hours**

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule Simpson's 3/8 rule – Romberg's method.

UNIT IV: Design of Experiments **9 hours**

Analysis of variance – One way classification – Completely randomized design – Two way classifications- Randomized Block design – Latin square

UNIT V: Statistical Quality Control **9 hours**

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np Charts) – Tolerance limits - Acceptance sampling.

.

TEXT BOOKS:

1. Grewal. B.S., and Grewal. J.S." Numerical methods in Engineering and Science", Khanna Publishers, 9th Edition, New Delhi, 2007.
2. Gerald. C. F., and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6 th Edition, New Delhi, 2006.

REFERENCES:

1. Chapra. S.C., and Canale.R.P., "Numerical Methods for Engineers, Tata McGraw Hill, 5 th Edition, New Delhi, 2007.
2. Brian Bradie. "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi, 2007.
3. Sankara Rao. K., "Numerical methods for Scientists and Engineers", Prentice Hall India Private, 3rd Edition, New Delhi, 2007.
4. M.R.Spiegel, J.Schiller and R. Alu Srinivasan R, "Schaum"s Outlines Probability and Statistics", Tata McGraw-Hill Publishing Company Ltd. New Delhi, 2007.

<table>
<tr><td>PROGRAM</td><td colspan="5">B. E., B.TECH.</td></tr>
<tr><td rowspan="2">Course Code: UEPHO02</td><td rowspan="2">INTRODUCTION TO NANOSCIENCE</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Year and Semester</td><td colspan="2">3, VI</td><td colspan="3" rowspan="2">COURSE [3 HRS]</td></tr>
<tr><td>Prerequisite course</td><td colspan="2">Fundamentals of Physics</td></tr>
<tr><td rowspan="3">Course category</td><td>Humanities and Social Sciences</td><td>Management courses</td><td>Professional Core</td><td colspan="2">Professional Elective</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Basic Science</td><td>Engineering Science</td><td>Open Elective</td><td colspan="2">Mandatory</td></tr>
<tr><td></td><td>✓</td><td></td><td>✓</td><td colspan="2"></td></tr>
<tr><td>Course Objective</td><td colspan="5">1. To Introduce Nanoscience to engineering students
2. To explain different nanomaterials synthesis methods
3. To illustrate nano materials and their interesting properties
4. To demonstrate about various nanomaterial characterization tools
5. To describe about various applications of nanoscience</td></tr>
<tr><td>Course Outcome</td><td colspan="5">After completion of the course, the students will be able to ,
1. To understand the basic concepts of nanomaterials.
2.To discuss the nanomaterial synthesis techniques
3.To analyze the properties of nanomaterials and their utility.
4. To apply the tools for nanomaterials study.
5. To apply Nanoscience for various applications
6. To apply the basic understanding of Nanoscience in fabrication of engineering devices</td></tr>
</table>

Pre- requisite **:**Higher Secondary School Education; Fundamental concepts of Physics

Knowledge Levels as per Bloom Taxonomy:

K1- Remember; K2- Understand; K3- Apply; K4- Analyse; K5- Evaluate; K6- Create

Mapping of CO vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO_1	1	1			3							3
CO_2	3	2		1		2						2
CO_3	2	2			1							3
CO_4	2	1		2		3	2					2
CO_5	1	3		3	2	1						1
CO_6	1	1		1	1	1	3					3
CO_7	3	2		2	2	3	1					2

Unit I Introduction to Nanoscience:(9 Hours)

Scientific Revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, influence of nano over micro/macro, size effects, large surface to volume ratio, surface effects on the properties, functional Materials, Composite materials.

Unit II Synthesis of nanomaterials: (9 Hours)

Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and coprecipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Sono chemical synthesis; Electrochemical synthesis, Process of self-assembly,

Fabrication of Nanomaterials by Physical Methods, Arc discharge, Ion sputtering, Laser ablation, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition method nanolithography, E beam lithography

Unit III Properties of nanomaterials:**(9 Hours)**

Nanostructures: Zero-, One-, Two- and Three- dimensional structure, Size control of semiconductor, metal, polymer Nanoparticles and their properties: Optical, Electronic, Magnetic properties; Surface plasmon Resonance, Change of bandgap.

Unit IV Characterization techniques:(9 Hours)

X-ray diffraction, Optical Microscope and their description, Scanning Electron Microscopy (SEM), TEM, DLS and EDAX analysis, UV-VIS-IR Spectrophotometers-band gap measurement, FTIR- ATR, TGA, DTA (Principle and Applications).

Unit V Nanomaterial Applications:(9 Hours)

Applications of nanomaterials in Environment, energy, medical &health care, electronics & communication and other Industrial applications.

Total : 45 Hours

Text Books

1. Textbook of Nanoscience and Nanotechnology, Murty, B.S., Shankar, P., Raj, B., Rath, B.B., Murday, J. Springer Berlin Heidelberg, 2013, Pgs 1-223.

2. Textbook of Nanoscience and Nanotechnology, T. Pradeep, 2012McGraw Hill Education (India) Private Limited, 1-445.

3. Basic Principles of Nanotechnology1st Edition, Wesley C. Sanders, CRC Press, 2018, Pgs 178.

References

1. Introduction to Nanoscience and Nanomaterials, , Dinesh C Agrawal , World Scientific Publishing Co Pte Ltd, 2013, Pgs 572

2. Essentials in Nanoscience and Nanotechnology, **Narendra Kumar**, **Sunita Kumbhat**, John Wiley & Sons, Inc., 2016, Pgs 472

<table>
<tr><td>PROGRAM</td><td colspan="5">All UG Programmes</td></tr>
<tr><td>Course Code:
UDCCO07</td><td colspan="2">Course Name : MARINE CHEMISTRY</td><td>L
3</td><td>T</td><td>P</td><td>C
3</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Year and Semester</td><td colspan="2"></td><td colspan="4" rowspan="2">Contact hours per week
3 Hrs</td></tr>
<tr><td>Prerequisite course</td><td colspan="2">NIL</td></tr>
<tr><td rowspan="2">Course category</td><td>General</td><td>Foundation</td><td colspan="2">Core / Professional</td><td colspan="2">Elective</td></tr>
<tr><td></td><td></td><td colspan="2"></td><td colspan="2">Yes</td></tr>
<tr><td>Course Objective</td><td colspan="6">1. By the end of this lesson, the student will be able to classify the different dissolved gases in sea water.
2. By the end of this lesson, the student will be able to predict the role of biological processes in affecting oceanic carbonate system.
3. By the end of this lesson, the student will be able to describe chemical and pharmacological properties of bioactive substances in marine organisms.
4. By the end of this lesson, the student will be able to determine micro-nutrient elements (N, P, Si) in seawater.
5. By the end of this lesson, the student will be able to identify dissolved elements in the estuary.</td></tr>
<tr><td>Course Outcome</td><td colspan="6">1. List the various dissolved gases in sea water and factors affecting their concentration.
2. Demonstrate knowledge of concepts and principles of ocean acidification.
3. Analyse and evaluate biomedical aspects of marine natural products.
4. Integrate and apply the knowledge of stoichiometry of uptake and regeneration of nutrients elements.
5. Reflect on the influence heavy metals in estuaries.
6. Evaluate total findings in marine chemistry to solve engineering problems</td></tr>
</table>

Total Hours: 45 Hrs

Unit 1 **9 hrs**

Dissolved gases in seawater

Dissolution of gases in seawater and their solubility; classification of dissolved gases and factors affecting their concentration in seawater; distribution of dissolved oxygen in seawater and affecting factors, AOU and oxygen minimum zone formation in the ocean, origin and consequences of ocean hypoxia.

Unit 2 **9 hrs**

Carbonate systems in the ocean

Acid base equilibria in seawater carbon dioxide system; parameters of carbonate systems and their distribution in the ocean; role of biological processes in affecting oceanic carbonate system; precipitation and dissolution of calcium carbonate in seawater, lysocline and carbonate compensation depth; Ocean acidification.

Unit 3 **9 hrs**

Chemistry of marine natural products

Biomedical Aspects; chemical and pharmacological properties of bioactive substances in marine organisms, carbohydrates and their derivatives in red and brown algae, aliphatic acids and their derivatives in marine organisms, steroids and their use as biomarkers, nitrogenous compounds in invertebrates, nucleosides from sponges, biopolymer.

Unit 4 **9 hrs**

Micronutrients in seawater

Micro-nutrient elements (N, P, Si) in seawater, their forms, distribution and seasonal variation in the ocean. Stoichiometry of uptake and regeneration of nutrients elements and AOU. Micronutrients and primary productivity.

Unit 5 **9 hrs**

Estuarine chemistry

Behavior of dissolved and particulate material during estuarine mixing, interaction among them and speciation of dissolved elements in the estuary; physico-chemical characteristic of estuarine sediment, anoxic sediments and pore water; heavy metals in estuaries and the processes affecting its distribution.

Reference books

1. Introduction to Marine Chemistry, 1971 – Riley, J.P. and Chester, R., Academic Press.

2. Chemical Oceanography (Vol.1, 2, 3 & 8), 1975 – Riley, J.P. & Skirrow, G., Academic Press.

3. Marine Chemistry, 1969 – Horne, R.A., Wiley-Interscience

4. Seawater: Its composition, properties & behaviour, 1989, 1995, 2004 – The Open University.

5. Marine Chemistry (Vol.2), 1970 – Martin, D.F., Marcel Dekker, NY.

6. Tracers in the Sea, 1982 – Broecker and Peng., Lamont-Doherty Geological Observatory, NY.

7. Marine Geochemistry, 1990, 2000 – Chester, R., Blackwell Science.

8. Chemical Oceanography, 1992 – Millero, F. J. and Sohn, M.L., CRC Press.

9. Dynamic processes in the chemistry of the upper ocean, 1986 - Burton et al., Plenum Press.

10. The chemistry of the Atmosphere and Oceans, 1978 – Holland, H.D., Wiley.