



SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

[M.Sc. Earth Science] Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2T02NCEAS01	Synthesis & Properties of Materials	4-0-1	120	04

• Course Learning Outcomes (CLOs)

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

CLO1:

Analyze the structure–property–processing relationships of diverse engineering materials and evaluate their suitability for advanced technological applications.

CLO2:

Critically evaluate various polymerization and polycondensation techniques to design polymeric materials with targeted structural and functional properties.

CLO3:

Develop and justify advanced polymeric materials by selecting suitable polymerization and processing strategies for specific industrial and functional applications.

CLO4:

Interpret and apply phase diagrams, glass-forming principles, and fabrication methods in the development of advanced ceramic and glass materials.

CLO5:

Assess and optimize the microstructure and heat-treatment processes of metals and alloys for improved mechanical and industrial performance.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Introduction to Various Materials Introduction to Materials & Materials Science. Type of materials, Properties of materials, levels of structure, processing of materials, structure- property – processing relationship. Environmental effect of Materials behavior, Materials selection.	CL, Seminar, RP	CLO1
II	Methods of Synthesis of Polymeric Materials Macromolecular concepts, structural feature of polymers, correlation between structure and properties of various polymerization methods. Bulk, solution, suspension and emulsion polymerization techniques, interfacial, melt and solution polycondensation, some other miscellaneous techniques.	CL, ICT, PBL	CLO2, CLO3
III	Glass and Ceramic Materials Various types of ceramics, phase diagrams, principles of main fabrication techniques. Nature of glass, structure, glass forming systems, silicate systems, non-silicate systems, Types of Glasses, manufacture of glass.	CL, Seminar SDL	CLO4
IV	Metals and Alloys Fe-Fe ₃ C phase diagram, pearlite, bainite, martensite, cementite, heat treatments processes, classification of steels and their applications. Aluminium alloys, magnesium alloys, copper alloys, nickel, cobalt, zinc alloys, titanium alloys, refractory metals.	CL, ICT, RP	CLO5



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[M.Sc. Earth Science] Semester-II

• (*) Learning Pedagogies/Methods

Notes:

(1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(2) Acronyms/abbreviations of the terms can be placed in the above table.

(a) Classroom Lecture (CL)

(b) Seminars (Student-led and Faculty-moderated)

(c) Case-Based Learning (CBL)

(d) Micro-Projects/Mini Research Tasks

(e) Industrial Visit/Field Visit/Institutional Visit

(f) Problem-Based Learning (PBL)

(g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)

(h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)

(i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)

(j) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)

(k) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)

(l) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)

(m) Inquiry-Based Learning

(n) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies

(A) Internal Assessment

a. Internal Formative assessment [30Marks]

(a) Assignment, Self-learning and Terms work

(b) Seminar/Presentation

(c) Quiz

(d) Attendance

b. Internal Summative Assessment [20Marks]

(a) Mid-term tests [20Marks]

(b) End of Term Examination

(c) Laboratory performance

(d) Viva-voce

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage(Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/Analyse & above (A)	
I	CLO1	30	2	3	7	12
II	CLO2, CLO3	30	2	3	9	14
III	CLO4	30	2	3	7	12
IV	CLO5	30	2	3	7	12
		120	8	12	30	50



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[M.Sc. Earth Science] Semester-II

• Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50%
2	End-Semester Examination	Written Exam	50%

(C) CLOs – PLOs Matrix

CLO	PLOs											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 0	PLO1 1	PLO1 2
CLO 1	2	2	3	2	2	1	2	1	-	-	1	2
CLO 2	1	2	1	3	2	2	2	1	1	1	2	1
CLO 3	1	1	1	3	3	2	2	2	1	1	2	2
CLO 4	3	2	3	1	2	1	1	1	-	-	1	1
CLO 5	2	2	3	2	1	1	2	1	-	-	1	1

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	The Science and Engineering of Materials	Donald R. Askeland, Wendelin J. Wright	8 th Edition, 2026	Cengage Learning
2	Polymer Science	V. R. Gowarikar, N. V. Vishwanathan, J. Sreedhar	1 st Edition, 1986	Wiley
3	Principles of Polymer Science	P. Bahadur, N. V. Sastry	2 nd Edition, 2005	Narosa Publishing House



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4	Materials Science and Metallurgy	V. D. Kodgire	42 nd Edition, 2014	Everest Publishing House
5	Physical Metallurgy: Principles and Practice	V. Raghavan	3 rd Edition, 2015	PHI Learning
6	Science of Engineering Materials	Manas Chanda	3 rd Edition, 2015	Macmillan Publishers
7	Ceramic Hardness	Ian McColm	1 st Edition, 1990	Springer

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL course on Introduction to materials science and engineering	https://onlinecourses.nptel.ac.in/noc25_mm17/preview
2	NPTEL course on Introduction to Polymer Science	https://nptel.ac.in/courses/104105124
3	NPTEL course on Non - Metallic Materials	https://onlinecourses.nptel.ac.in/noc21_mm14/preview
4	NPTEL Video Course : Principles of Physical Metallurgy	http://www.digimat.in/nptel/courses/video/113105024



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[M.Sc. Earth Science] Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2T02NCEAS02	Instrumentation	4-0-1	120	04

• **Course Learning Outcomes (CLOs)**

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

CLO1: Analyze and evaluate the static and dynamic performance characteristics of measurement systems for accurate instrumentation design and error compensation.

CLO2: Critically assess the selection, modeling, and operational principles of transducers for advanced physical parameter measurements.

CLO3: Develop and justify suitable transducer circuits and signal conditioning techniques for reliable measurement and instrumentation systems.

CLO4: Design and optimize sensor-based process measurement systems for pressure, temperature, force, and torque applications.

CLO5: Evaluate and interpret the performance of optoelectronic devices, optical detectors, and optical fiber systems for modern sensing applications.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Characteristics of Instruments Generalized scheme of a measurement systems, basic methods of measurements, Errors in measurements, types of errors. Reliability of measurement systems, failure rate, reliability improvement, availability, redundancy, choice of components, and materials. Different types of noises in measurements and its suppression methods. Static characteristics of instruments – accuracy, precision, sensitivity, linearity, resolution, hysteresis, threshold, input impedance, loading effect – generalized mathematical model of measurement systems – dynamic characteristics – Modeling of Transducers – operational transfer function – zero, first and second order instruments – impulse, step, ramp and frequency response of the above instruments-techniques for dynamic compensation	CL, Seminar, RP	CLO1
II	Transducers Classification and Basic requirements of Transducers, selection of transducers, Principles of displacement Transduction, circuit based on transduction. Temperature transducer, displacement transducer, pressure transducers and catheter tip transducers., Strain: Factors affecting strain measurements, operation of resistance gauge, types of Characteristics devices Piezoelectric: Phenomenon Force, strain, torque, pressure & acceleration Transducer Hall Effect transducers & applications, photoconductive and photo-emissive transducers, Ionization displacement transducer, nuclear radiation transducer, radioactive transducers, digital transducers.	CL, Seminar, ICT, PBL	CLO2, CLO3

III	Process Measurements & Sensors Pressure: Diaphragms, Elastic elements, Transduction Methods, Solid	CL, Seminar SDL	CLO4
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	state, thin film, Calibration, Platinum type sensors, Thermistors, Thermocouples, IC Temperature Sensors, Radiation measurement, optical pyrometers, calibration, Force: Load cell and its types, Torque measurement and its types.		
IV	Optoelectronics Optical sources: LED- Introduction, Structures & characteristics, LASER Basic concepts, optical Emission from semiconductor & non semiconductor LASERS. Optical detectors: Introduction, detection principles, absorption, quantum efficiency, responsively, Long wavelength cut off, phototransistors and photoconductive detectors. Optical fiber, Ray theory, single mode fibers, attenuation, losses, dispersion, polarization, Refractive Index profile, cut off wavelength measurement etc.. advantages/ disadvantages and various applications.	CL, ICT, RP	CLO5

- **(* Learning Pedagogies/Methods**

Notes:

(3) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(4) Acronyms/abbreviations of the terms can be placed in the above table.

(o) Classroom Lecture (CL)

(p) Seminars (Student-led and Faculty-moderated)

(q) Case-Based Learning (CBL)

(r) Micro-Projects/Mini Research Tasks

(s) Industrial Visit/Field Visit/Institutional Visit

(t) Problem-Based Learning (PBL)

(u) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)

(v) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)

(w) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)

(x) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)

(y) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)

(z) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)

(aa) Inquiry-Based Learning

(bb) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(D) Internal Assessment

a. Internal Formative assessment [30Marks]

(e) Assignment, Self-learning and Terms work

(f) Seminar/Presentation

(g) Quiz

(h) Attendance

b. Internal Summative Assessment [20Marks]

(e) Mid-term tests [20Marks]



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[M.Sc. Earth Science] Semester-II

(f) End of Term Examination

(g) Laboratory performance

(h) Viva-voce

(E) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage(Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1	30	2	3	7	12
II	CLO2, CLO3	30	2	3	7	12
III	CLO4	30	2	3	9	14
IV	CLO5	30	2	3	7	12
		120	8	12	30	50

• Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50%
2	End-Semester Examination	Written Exam	50%

(F) CLOs – PLOs Matrix

CLO	PLOs											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 0	PLO1 1	PLO1 2
CLO 1	2	2	2	1	3	3	3	2	-	-	1	2
CLO 2	2	2	3	1	3	2	3	1	-	-	2	2
CLO 3	1	3	1	-	3	1	3	2	1	-	-	2
CLO 4	2	3	3	2	2	2	3	2	1	1	3	2
CLO 5	3	2	3	2	2	1	3	2	-	-	2	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.



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[M.Sc. Earth Science] Semester-II

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• Suggested Learning Materials Books:

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Instrumentation Devices and Systems	C. S. Rangan, G. R. Sarma, V. S. V. Mani	2 nd Edition, 1997	Tata McGraw-Hill Publishing Company
2	Transducers and Instrumentation	D. V. S. Murty	2 nd Edition, 2010	PHI Learning Pvt. Ltd.
3	Instrumentation Measurement and Analysis	B. C. Nakra, K. K. Chaudhry	4 th Edition, 2015	Tata McGraw-Hill Education
4	Principles of Industrial Instrumentation	D. Patranabis	3 rd Edition, 2017	Tata McGraw-Hill Education
5	Electronic Instrumentation	H. S. Kalsi	4 th Edition, 2019	McGraw-Hill Education
6	Electronic Instrumentation and Instrumentation Technology	M. M. S. Anand	Reprint Edition, 2004	Prentice Hall of India, New Delhi
7	Optical Fiber Communications: Principles and Practice	John M. Senior	3 rd Edition, 2009	Pearson Education
8	Semiconductor Optoelectronic Devices	Pallab Bhattacharya	2 nd Edition, 1997	Prentice Hall of India Pvt. Ltd.
9	Advanced Electronic Communication Systems	Wayne Tomasi	6 th Edition, 2010	Pearson Education / Prentice Hall

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL YouTube Lecture: General Principles of Measurement Systems – lecture module on instrumentation fundamentals and measurement system concepts.	https://www.youtube.com/watch?v=jnY9T4Bf9h8&utm_source=chatgpt.com
2	NPTEL lecture based on Industrial Instrumentation	https://onlinecourses-archive.nptel.ac.in/noc17_ec09/preview
3	NPTEL lecture based on Transducers for Instrumentation	https://onlinecourses.nptel.ac.in/noc26_ee29/preview?utm_source=chatgpt.com
4	NPTEL lecture based on Biomedical Instrumentation	https://onlinecourses.nptel.ac.in/noc25_bt49/preview?utm_source=chatgpt.com

Course	Course Code	Course Title	Teaching-	Total	Course
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[M.Sc. Earth Science] Semester-II

Type			Learning Scheme	Notional Hours	credits
			L-P-T		
DSC	P2T02NCEAS03	Characterization Techniques	4-0-1	120	04

• Course Learning Outcomes (CLOs)

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

CLO1:

Critically evaluate the principles, instrumentation, and analytical performance of advanced spectroscopic techniques for qualitative and quantitative chemical analysis.

CLO2:

Examine the applications and limitations of UV-Visible and IR spectroscopic techniques for identification of functional groups and quantitative analysis of chemical systems.

CLO3:

Interpret and correlate NMR, and Mass spectra to elucidate molecular structure, composition, and physicochemical properties of complex systems..

CLO4:

Analyze thermal behavior and reaction kinetics of inorganic, organic, and polymeric materials using advanced thermal analytical methods.

CLO5:

Assess scattering and X-ray characterization techniques for determining particle size, crystallinity, elemental composition, and structural properties of materials.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	<p>Spectroscopic Techniques UV-Visible Molecular Absorption Spectrometry: Transmittance and Absorption, Beer's law and its applications to mixtures, Deviation from Beer's law, Instrument components, Types of instruments (Single beam, double beam, multichannel etc.) Applications: Molar Absorptivity, Absorption by Organic Compounds, Inorganic Compounds and Charge transfer complexes, Detection of functional groups, Quantitative analysis, Photometric Titrations. IR Spectrometry: Introduction, theory, Types of vibrations and rotations, Mechanical model, Quantum treatment, Selection Rules and vibrational coupling, Instrumentation-Design and Components, Dispersive and nondispersive instruments, Source and Transducers. Applications of Near-, Mid- and Far- IR, Sample preparation, Qualitative analysis (group frequencies, fingerprint region) and Quantitative applications – analysis of mixtures of aromatic hydrocarbons, determination of air contaminants, applications of NIR absorption and reflectance spectroscopy.</p>	CL, Seminar, RP	CLO1, CLO2
II	<p>NMR and Mass Spectrometry Nuclear Magnetic Resonance Spectrometry: Theory of NMR (quantum description, energy levels, classical descriptions, relaxation processes), FT NMR, Environmental effects on NMR spectra (types, origin of chemical shift, spin-spin splitting, theory of chemical shift).</p>	CL, Seminar, ICT, PBL	CLO3



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	<p>Applications of ¹³C-NMR (quantitative analysis, structure determination, applications to solid samples). Molecular Mass Spectrometry: Molecular Mass Spectrum, Ion Sources and types, Ion Sources and spectra, Desorption sources and Methods-MALDI, ESI, Instrumentation (General Description and Instrument components, Resolution and Analyzers).</p> <p>Applications: Identification of pure compounds, Molar masses, Molecular formula, Structural information, Analysis of mixtures, Quantitative applications.</p>		
III	<p>Thermal Methods Types of Techniques: TGA, DTA, DSC and Microthermal methods, (Instrumentation and components of each of above), Combined Thermal Instruments- TGA-MS, TGA-FTIR. Applications: TGA for monitoring Kinetics and Physical processes induced by temperature in inorganic and polymeric materials. DTA-Polymer Characterization, DSC-Glass Transition Temperature, Crystallinity and Reaction Kinetics of processes involving polymers.</p>	CL, Seminar SDL	CLO4
IV	<p>Scattering and X-Ray Methods Scattering Methods: Low angle Laser Light Scattering and Dynamic Light Scattering, Introduction to Particle Size Analysis, Instrumentation, Theoretical models, Size distribution analysis. Applications for polymer solution and colloidal dispersions. X-Ray Methods: Spectral Lines, X-Ray tubes, X-ray Emission, Spectrum, Absorption, Instrumentation and Detectors, Chemical analysis by X-ray absorption, X-Ray Fluorescence and Chemical analysis, X-Ray Diffraction methods and Structural elucidation.</p>	CL, ICT, RP	CLO5

- (*) **Learning Pedagogies/Methods**

Notes:

(5) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

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(cc) Classroom Lecture (CL)

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(gg) Industrial Visit/Field Visit/Institutional Visit

(hh) Problem-Based Learning (PBL)

(ii) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)

(jj) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)

(kk) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)

(ll) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)

(mm) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)

(nn) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)

(oo) Inquiry-Based Learning

(pp) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- Assessment Methodologies**



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[M.Sc. Earth Science] Semester-II

(G) Internal Assessment

a. Internal Formative assessment [30Marks]

- (i) Assignment, Self-learning and Terms work
- (j) Seminar/Presentation
- (k) Quiz
- (l) Attendance

b. Internal Summative Assessment [20Marks]

- (i) Mid-term tests [20Marks]
- (j) End of Term Examination
- (k) Laboratory performance
- (l) Viva-voce

(H) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage(Marks) to Learning levels (BT)			Total Marks
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IV	CLO5	30	2	3	7	12
		120	8	12	30	50

• Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50%
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(I) CLOs – PLOs Matrix

CLO	PLOs											
	PL O1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO1 0	PLO1 1	PLO1 2
CLO1	2	2	3	1	2	3	3	2	-	-	1	2
CLO2	2	1	3	2	2	2	3	1	-	-	1	1
CLO3	2	2	3	1	2	3	3	2	-	-	-	2
CLO4	3	2	3	1	2	2	2	1	-	-	1	1
CLO5	3	2	3	2	2	3	3	2	-	-	1	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.



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[M.Sc. Earth Science] Semester-II

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	<i>Introduction to Instrumental Analysis</i>	Robert D. Braun	1 st Edition, 1987	McGraw-Hill / Pharma-Med Press
2	<i>Fundamentals of Analytical Chemistry</i>	Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch	10 th Edition, 2022	Cengage Learning
3	<i>Instrumental Methods of Analysis</i>	H. H. Willard, L. L. Merritt Jr., J. A. Dean, F. A. Settle Jr.	7 th Edition, 1988	CBS Publishers & Distributors, New Delhi
4	<i>Solid State Chemistry: An Introduction</i>	Lesley E. Smart, Elaine A. Moore	4 th Edition, 2012	CRC Press
5	<i>Instrumental Analysis</i>	Douglas A. Skoog, F. James Holler, Stanley R. Crouch	1 st India Edition, 2017	Cengage India
6	<i>Principles of Instrumental Analysis</i>	Douglas A. Skoog, F. James Holler, Stanley R. Crouch	7 th Edition, 2017	Cengage Learning / Thomson Brooks-Cole

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL Course: Analytical Chemistry	https://nptel.ac.in/courses/104105084
2	NPTEL Course: Principles and Applications of NMR Spectroscopy	https://nptel.ac.in/courses/104108078
3	NPTEL Course: Fundamentals of X-ray diffraction and Transmission electron microscopy	https://nptel.ac.in/courses/113106069
4	NPTEL Course: Modern Instrumental Methods of Analysis	https://nptel.ac.in/courses/103108100

Course	Course Code	Course Title	Teaching-	Total	Course
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[M.Sc. Earth Science] Semester-II

Type			Learning Scheme	Notional Hours	credits
			L-P-T		
DSC	P2T02NCEAS04	Practical based on P2T02NCEAS01 & P2T02NCEAS03	0-4-0	120	04

- **Course Learning Outcomes (CLOs)**

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

CLO1:

Execute the synthesis of thermosetting resins (Urea, Phenol, and Melamine-Formaldehyde) and evaluate their quality by quantifying residual free formaldehyde through analytical titration or spectroscopic methods.

CLO2:

Analyze and interpret FTIR spectra to identify functional groups and utilize LCMS (Liquid Chromatography-Mass Spectrometry) for the qualitative identification of complex hydrophobic molecules.

CLO3:

Demonstrate competency in quantitative chemical analysis by applying UV-Vis Spectroscopy and Elemental Analysis to determine the concentration and elemental composition of liquid samples and environmental sediments.

CLO4:

Critically evaluate the thermal stability, phase transitions, and decomposition kinetics of materials (e.g., Calcium Oxalate) using Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC).

CLO5:

Integrate elemental and spectroscopic data to assess the geochemical properties of sediment samples, ensuring precision, accuracy, and adherence to laboratory safety and ethical protocols.

Unit	Course Content	Learning Pedagogies*	CLO(s)
	1. Qualitative analysis of hydrophobic drugs by liquid chromatography mass spectroscopy method (LCMS). 2. Synthesis of Urea-Formaldehyde Resins and identify % free formaldehyde from the synthesized resin. 3. Synthesis of Phenol -Formaldehyde Resins and identify % free formaldehyde from the synthesized resin. 4. Quantitative determination of given sample solution by UV-Vis Spectroscopy. 5. Identify the functional groups present in the given sample by FTIR spectral techniques. 6. Thermo gravimetric (TGA) and differential scanning calorimetric (DSC) analysis of Calcium oxalate sample. 7. Synthesis of Melamine -Formaldehyde Resins and identify % free formaldehyde from the synthesized resin. 8. Elemental analysis and quantitative determination of sediment	Experiential Learning, Collaborative Learning, PBL, SDL	CLO1, CLO2, CLO3, CLO4, CLO5



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[M.Sc. Earth Science] Semester-II

	using elemental analyzer.		
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- (* Learning Pedagogies/Methods**

Notes:

(7) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(8) Acronyms/abbreviations of the terms can be placed in the above table.

(qq) Classroom Lecture (CL)

(rr) Seminars (Student-led and Faculty-moderated)

(ss) Case-Based Learning (CBL)

(tt) Micro-Projects/Mini Research Tasks

(uu) Industrial Visit/Field Visit/Institutional Visit

(vv) Problem-Based Learning (PBL)

(ww) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)

(xx) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)

(yy) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)

(zz) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)

(aaa) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)

(bbb) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)

(ccc) Inquiry-Based Learning

(ddd) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- Assessment Methodologies**

(J) Internal Assessment

a. Internal Formative assessment [30Marks]

(m) Practical performance

(n) Journal preparation

(o) Viva voce

(p) Attendance

b. Internal Summative Assessment [20Marks]

(m) Mid-term tests [20Marks]

(n) End of Term Examination

(o) Laboratory performance

(p) Viva-voce

(K) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage(Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
Practical 01 to 07	CLO1, CLO2, CLO3, CLO4, CLO5	120	5	10	35	50



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• Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Practical performance, Journal preparation, Viva voce, Attendance	50%
2	End-Semester Examination	University Practical Examination	50%

(L) CLOs – PLOs Matrix

CLO	PLO										PLO1 1	PLO1 2
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 0		
CLO 1	1	2	2	2	2	3	2	1	1	1	-	1
CLO 2	2	1	3	1	2	3	3	2	-	-	1	2
CLO 3	2	3	3	2	2	3	3	2	1	1	2	1
CLO 4	3	2	3	1	2	3	3	1	-	-	1	1
CLO 5	3	2	3	3	2	3	2	3	2	3	3	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Principles of Instrumental Analysis	Douglas A. Skoog, et al.	7th Edition / 2017	Cengage Learning
2	Vogel's Textbook of Quantitative Chemical Analysis	J. Mendham, et al.	6th Edition / 2000	Pearson Education
3	Polymer Synthesis and Characterization: A Laboratory Manual	Stanley R. Sandler, et al.	1st Edition / 1998	Academic Press
4	Principles of Instrumental Analysis	Douglas A. Skoog, et al.	7th Edition / 2017	Cengage Learning



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2T02NCEAS05	Practical based on P2T02NCEAS02 & P2T02NCEAS06	0-4-0	120	04

• Course Learning Outcomes (CLOs)

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

CLO1:

Analyze the electronic transport properties of semiconductors and optoelectronic devices by determining Hall coefficients, carrier dynamics, and LED barrier voltages, and utilize these characteristics to estimate fundamental physical constants like Planck's constant.

CLO2:

Evaluate the operational principles and performance of industrial transducers, including LVDT, Strain Gauges, and Load Cells, by characterizing their sensitivity, linearity, and response to physical stimuli.

CLO3:

Investigate phase transitions and thermoelectric phenomena by determining the Curie temperature of ferroelectric materials and analyzing the Seebeck and Peltier effects in thermocouples.

CLO4:

Design, construct, and test R-2R ladder DAC and ADC circuits, demonstrating a practical understanding of signal conversion, resolution, and the integration of digital logic with analog systems.

CLO5:

Synthesize experimental findings by applying rigorous Error Estimation and the Method of Least Square Fit to ensure the scientific validity and precision of measurements in laser diode and semiconductor characterization.

Unit	Course Content	Learning Pedagogies*	CLO(s)
	1. Error estimations in experimental observations and method of least square fit 2. Study of Hall Effect in semiconductor and to determine Hall Co-efficient, Hall voltage, carrier density, carrier mobility and find out type of the semiconductor. 3. Characteristics of the Linear Variable Differential Transducer (L.V.D.T) 4. I-V-T characteristics of LED below the barrier voltage V_0 (firing voltage) (ON voltage) and to find out the material constant η and the barrier voltage V_0 , also to estimate the Planck's constant based on the LED characteristics	Experiential Learning, Collaborative Learning, PBL, SDL	CLO1, CLO2, CLO3, CLO4, CLO5



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5. Study of the strain gauge characteristics		
6. Study of the Load cell characteristics		
7. Study of the LASER beam Diode characteristics. Determination of Optical Power (Po) of a Laser Diode and LASER diode Forward current (Ip)		
8. Determination of the Curie temperature for ferroelectric materials.		
9. Study of the Thomson-Seebeck effect and Peltier effect using Thermocouple		
10. Design and Construction of a 4 bit R 2R ladder DAC (digital to analog conversion) circuit and ADC (analog to digital circuit). To plot the curve of 4 bit R 2R ladder DSC circuit		

- **(* Learning Pedagogies/Methods**

Notes:

(9) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(10) Acronyms/abbreviations of the terms can be placed in the above table.

(eee) Classroom Lecture (CL)

(fff) Seminars (Student-led and Faculty-moderated)

(ggg) Case-Based Learning (CBL)

(hhh) Micro-Projects/Mini Research Tasks

(iii) Industrial Visit/Field Visit/Institutional Visit

(jjj) Problem-Based Learning (PBL)

(kkk) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)

(lll) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)

(mmm) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)

(nnn) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)

(ooo) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)

(ppp) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)

(qqq) Inquiry-Based Learning

(rrr) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(M) Internal Assessment

a. Internal Formative assessment [30Marks]

(q) Practical performance

(r) Journal preparation

(s) Viva voce

(t) Attendance

b. Internal Summative Assessment [20Marks]

(q) Mid-term tests [20Marks]

(r) End of Term Examination

(s) Laboratory performance



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(t) Viva-voce

(N) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage(Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
Practical 01 to 07	CLO1, CLO2, CLO3, CLO4, CLO5	120	5	10	35	50

• Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Practical performance, Journal preparation, Viva voce, Attendance	50%
2	End-Semester Examination	University Practical Examination	50%

(O) CLOs – PLOs Matrix

CLO	PLO											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 0	PLO 1	PLO 2
CLO 1	3	2	2	-	2	2	3	1	-	-	-	2
CLO 2	2	2	3	1	2	2	3	1	1	-	2	1
CLO 3	3	2	3	-	2	2	2	1	-	-	1	1
CLO 4	1	3	2	-	3	1	3	2	1	-	-	2
CLO 5	1	3	2	1	2	3	2	3	2	2	1	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-



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- Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Electronic Instrumentation	H. S. Kalsi	4th Edition	McGraw Hill
2	Op-Amps and Linear Integrated Circuits	Ramakant A. Gayakwad	4th Edition	Pearson
3	Measurement Systems: Application and Design	Ernest O. Doebelin	7th Edition	McGraw Hill
4	Digital Principles and Applications	Donald P. Leach & Albert P. Malvino	8th Edition	McGraw Hill
5	An Advanced Course in Practical Physics	D. Chattopadhyay & P. C. Rakshit	15th Edition	New Central Book Agency



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2T02NCEAS06	Environmental Science, Health and Safety	2-0-0	60	02

• Course Learning Outcomes (CLOs)

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

CLO1:

Analyze the physical and chemical mechanisms of material degradation across diverse environments, including atmospheric, marine, industrial, and space (vacuum) conditions.

CLO2:

Evaluate the sources and effects of terrestrial and aquatic pollutants—specifically heavy metals (Arsenic, Fluoride), pesticides, and industrial effluents—on material integrity and ecosystem health.

CLO3:

Critically assess the impact of extreme physical stressors such as thermal shock, solar radiation (UV), and moisture on the optical and structural properties of engineering materials and solar cells.

CLO4:

Formulate and justify technical strategies for the control of pollution and material deterioration, incorporating thermal protection, microbial degradation prevention, and lubrication techniques.

CLO5:

Design and interpret standardized life tests (e.g., Dry Heat and Damp Heat tests) to predict the durability and sublimation/evaporation losses of materials in high-stress environments.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Degradation of Materials in different Environments: Atmospheric, underground marine & Industrial environment pollution, vacuum and space environment, biophysical; Sources of air pollutions, water pollution (fluoride and arsenic contamination); Industrial Effluents, pollution due to Sewage and Sludge, pesticides pollution, Solid waste problems, metal pollutants (e.g., As and fluoride); Environmental carcinogens, Control of pollution; Effects of heat, radiation and moisture.	CL, Seminar, RP	CLO1, CLO2, CLO3
II	Weathering, Air & Moisture, Radiation and Heat, Pollutants, Microbial degradations, Control of deterioration, thermal protection; Optical properties, solar cells, Lubrications, sublimation/evaporation, loss of materials; Thermal shock. Life tests such as Dry heat tests; Damp Heat	CL, Seminar, ICT, PBL	CLO4, CLO5



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• (*) Learning Pedagogies/Methods

Notes:

(11) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

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(ttt) Seminars (Student-led and Faculty-moderated)

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(www) Industrial Visit/Field Visit/Institutional Visit

(xxx) Problem-Based Learning (PBL)

(yyy) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)

(zzz) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)

(aaaa) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)

(bbbb) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)

(cccc) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)

(dddd) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)

(eeee) Inquiry-Based Learning

(ffff) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies

(P) Internal Assessment

a. Internal Formative assessment [15Marks]

(u) Assignment, Self-learning and Terms work

(v) Seminar/Presentation

(w) Quiz

(x) Attendance

b. Internal Summative Assessment [10Marks]

(u) Mid-term tests [20Marks]

(v) End of Term Examination

(w) Laboratory performance

(x) Viva-voce

(Q) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage(Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2, CLO3	30	1	4	8	13
II	CLO4, CLO5	30	1	3	8	12
		60	02	07	16	25



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- Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50%
2	End-Semester Examination	Written Exam	50%

(R) CLOs – PLOs Matrix

CLO	PLO										PLO1 1	PLO1 2
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 0		
CLO 1	3	2	3	2	1	2	1	-	-	-	1	1
CLO 2	3	2	3	3	2	2	2	2	-	2	3	1
CLO 3	2	2	3	2	2	1	3	1	-	-	2	2
CLO 4	2	3	1	3	3	1	2	2	1	2	3	2
CLO 5	1	2	2	2	3	3	2	3	-	-	2	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Theory of Corrosion and Protection of Metals	Tomashov N. D.	-	The Macmillan Company
2	Science of Engineering Materials	Manas Chanda	-	Macmillan Publishers
3	Waste recycling for energy conservation	Davidkut and Gerard Nare	-	-
4	Nuclear Physics	Irwing Kaplan	-	Addison-Wesley Publishing Company



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5	Introductory Nuclear Physics	Kenneth S. Krane	-	Wiley Publications
6	Theory of Corrosion and Protection of Metals	Tomashov N. D.	-	The Macmillan Company
7	Corrosion Engineering	M. G. Fontana	-	Tata McGraw Hill

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Corrosion Failures and Analysis	https://onlinecourses.nptel.ac.in/noc23_mm17/preview
2	Waste to Energy Conversion	https://onlinecourses.nptel.ac.in/noc22_ch52/preview