Complex Engineering Problem

During the theory courses students were given insights on the various types of water related projects they can work upon and were encouraged to undertake small projects, internship etc on topics related to water. The following students took part in various activities and the outcomes and associated POs are given in the table.

Name of students	**Activity**	**Outcome(s)**	**POs addressed & Justification**
Sreelekshmi S, Gayathri H, Gowtham Mohan, Gopika Sankar	Internship at Tokyo Metropolitan University, Japan End Semester Project	Paper on 'A New Index for the Assessment of Trophic Status of Estuarine System' presented at Asia Oceania Geosciences Society, Singapore	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to eutrophication PO4: used multiple criteria for problem analysis PO5: Studied and used ANN tool PO6: Addresses a societal problem PO8: Prepared the report adopting ethical principles PO9: Conducted field and lab analysis as a team PO10: Communicated the work in the conference session effectively PO12: Showcased the interest for learning new concepts
Ashwin Rajeev, Megha R, Amala Michael. Nikhil Solomon Varghese	Started mini project and lead to End Semester Project	Student Award worth $300 for the paper on 'Influence of non-cohesive sediments on settling velocity of clay floc in Bouregreg estuary' during 26th Biennial International Conference of Coastal Estuarine and Research Federation, USA	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to clay floc settling PO4: Used multiple criteria for problem analysis PO6: Addresses a societal problem PO8: prepared the report adopting ethical principles PO9: Conducted the analysis as a team PO10: Communicated the work in the conference session effectively PO12: Showcased the interest for learning new concepts
Haritha R, Athulya R S, Gopika S,	Internship at University of Philippines	Student Award worth $400 for the paper on 'Study on the settling	PO1: Applied Mathematics, Science, Civil Engineering principles;

Sankeerthana Suresh	Los Banos	velocity of suspended sediments in the Pasig River estuary, Philippines' during 26th Biennial International Conference of Coastal Estuarine and Research Federation, USA	PO2: Analyzed problem related to sediment dynamics PO4: Used multiple criteria for problem analysis PO6: Addresses a societal problem PO8: Prepared the report adopting ethical principles PO9: Conducted the analysis as a team PO10: Communicated the work in the conference session effectively PO12: Showcased the interest for learning new concepts
Vidya A, Anupama A, Athira M, Gopika Krishnan, Aparna Anil, Gokul T G	Started mini project and lead to End Semester Project	Paper on 'Predicting the water turbidity and evaluation of clariflocculation process of two coagulants through a coupled approach of micro-scale investigations and ANN modelling' under review in the SCI indexed International Journal - Soft Computing	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem of turbidity and its removal PO4: used multiple criteria for problem analysis PO5: Studied and used ANN tool PO6: Addresses a societal problem PO8: Prepared the report adopting ethical principles PO9: Conducted lab analysis as a team PO10: Communicated the work in the form of a manuscript effectively PO12: Showcased the interest for learning new concepts
Vishnu Raj, Abhijith R Nair, Abhinand A S, Vikhnesh C	End Semester Project	Paper on 'A fuzzy logic model for evaluation of eutrophication status of freshwater lakes' during the International Conference organized by CWRDM, Kozhikode	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to eutrophication PO4: used multiple criteria for problem analysis PO5: Studied and used Fuzzy Logic tool PO6: Addresses a societal problem PO8: Prepared the report adopting ethical principles PO9: Conducted field and lab analysis as a team

			PO10: Communicated the work in the conference session effectively PO12: Showcased the interest for learning new concepts
Cletus A, Athira S, Ramesh A G	Started mini project and lead to End Semester Project	Book Chapter on 'Performance Evaluation of Electrocoagulation with Hybrid Electrodes in the Decolourisation of Methyl Orange Dye'. In: Laishram B., Tawalare A. (eds) Recent Advancements in Civil Engineering. Lecture Notes in Civil Engineering, vol 172. Springer, Singapore.	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to dye contamination PO4: used multiple geometries of rlrcrodes for problem analysis PO6: Addresses a societal problem PO8: Prepared the report adopting ethical principles PO9: Conducted lab analysis as a team PO10: Communicated the work in the book chapter effectively PO12: Showcased the interest for learning new concepts
Archana D. S., Drisya S. Dharan	One student (Drisya S Dharan) completed internship from IIT Bombay. The junior student was connected with the 2015-19 batch and the work was continued	Spatiotemporal variability of multifractal properties of fine resolution daily gridded rainfall fields over India; Published in *Nat Hazards* **106**, 1951–1979 (2021). https://doi.org/10.1007/s11069-021-04523-0	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to rainfall complexity PO4: Evaluated the multifractal complexity of Indian rainfall PO5: Learned MATLAB software and modified the codes PO8: Prepared the report adopting ethical principles PO9: Conducted the project work as team; students of junior and senior batches was connected PO10: Communicated the work journal PO12: Showcased the interest for learning purely new concepts of interdisciplinary nature and applied in Civil Engg field
Archana D. S., Nityanjaly L. J., Vandana T, NandhineeKr	Some students in this group done a course project in	Multifractal Cross Correlation Analysis of Agro-Meteorological Datasets (Including Reference	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analysed problem related to rainfall complexity

ishna P	Semester 5. Continued the work as UG project in the similar field	Evapotranspiration) of California, United States *Atmosphere* **2020**, *11*, 1116. https://doi.org/10.3390/atmos11101116	PO4: Analyzed the Multifractal Cross Correlations of Agro-Meteorological Datasets using a new approach PO5: Learned the MATLAB software and developed the codes PO8: Prepared the report adopting ethical principles PO9: Conducted the project work as team; students of junior and senior batches was connected PO10: Communicated the work journal PO12: Showcased the interest for learning purely new concepts of interdisciplinary nature and applied in Civil Engg field
Nityanjaly L. J., Sarang R., Nandhineekrishna P.	Students in this group done a course project in Semester 5. Continued the work as UG project in the similar field	Multifractal characterization and cross correlations of reference evapotranspiration time series of India. *Eur. Phys. J. Spec. Top.* **230**, 3845–3859 (2021). ttps://doi.org/10.1140/epjs/s11734-021-00325-4	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to hydro-meteorological complexity PO4: Evaluated the differences multifractality of Evapotranspiration estimates of India, by different methods PO5: Learned MATLAB software and developed the codes PO8: Prepared the report adopting ethical principles PO9: Conducted the project work as team; students of junior and senior batches was connected PO10: Communicated the work journal PO12: Showcased the interest for learning purely new concepts of interdisciplinary nature and applied in Civil Engg field
M. Soorya Gayathri K. Shehinamol,	Students learned new methods; performed	Evaluation of change points and persistence of extreme climatic indices across India *Nat*	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2 : Analysed problem related

Zaina Nizamudeen, Mahima R. Lal	coding for the UG project work	*Hazards* **116**, 2747–2759 (2023). https://doi.org/10.1007/s11069-022-05787-w	to extreme indices using precipitation and rainfall data PO4: Research question on persistence of extreme climate indices is addressed PO5: Learned MATLAB software and done coding PO8: Prepared the report adopting ethical principles PO9: Conducted the project work as team; students of junior and senior batches was connected PO10: Communicated the work journal PO12: Showcased the interest for learning new concepts
Aggie Suman, Archana D. S.	One student (Aggie suman) done internship at IITB. The junior student was connected with the senior student and the work developed as a paper. Even after they graduated students show cased interest to complete and publish	Unveiling the climatic origin of streamflow persistence though multifractal analysis of hydro-meteorological datasets of India, *Hydrological Sciences Journal*, *68*(2), 290–306. https://doi.org/10.1080/02626667.2022.2157726	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to hydrologic complexity PO4: A research question on the origin of streamflow persistence is addressed and solved using inter disciplinary knowledge PO5: Learned MATLAB software and performed coding PO8: Prepared the report adopting ethical principles PO9: Students of junior and senior batches was connected PO10: Communicated the work to a journal PO12: Showcased the interest for learning new concepts
Sneha Binoy, Jyoma J P, Alisha A, Sreeshma T	UG student project work	Flood risk analysis and Mapping under compound hazards: A copula approach for tropical coastal district of Alappuzha, India. Journal of Hydro-environment Research 46, 2023, 60-71, https://doi.org/10.1016/j.jher.2022.11.004	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to flood risk PO4: A research question on compound hazards is addressed using advanced mathematical tool of Copulas PO5: Learned MATLAB software and performed relevant coding

			PO8: Prepared the report adopting ethical principles PO9: Conducted the project work as team PO10: Communicated the work to a journal PO12: Showcased the interest for learning new and complex mathematical concepts
S. Fathima, Nimisha Baiju, S. Meenakshi, M. Soumya Krishnan	The students worked with research scholar and learned coding	Analysing the streamflow teleconnections of greater Pampa basin, Kerala, India using wavelet coherence. Physics and Chemistry of the Earth, Parts A/B/C,6, 131, 2023, 10344https://doi.org/10.1016/j.pce.2023.103446	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to hydro-climatic teleconnections PO4: A research question on hydro-climatic teleconnection is addressed using wavelet coherence theory PO5: Learned MATLAB software and performed relevant coding PO8: Prepared the report adopting ethical principles PO9: Conducted the project work as team; students were connected with research scholar PO10: Communicated the work to a journal PO12: Showcased the interest for learning interdisciplinary knowledge
Shamseena Vahab, Aayisha Salim	Students completed internship at IIT Bombay Learned MATLAB and multifractal theory Currently developing a new method for fractality detection based on complex network as	Assessment of Multifractal Fingerprints of Reference Evapotranspiration Based on Multivariate Empirical Mode Decomposition. *Atmosphere* **2023**, *14*, 1219. https://doi.org/10.3390/atmos14081219 Also two conference papers they presented (NIT Warangal and VIT)	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related fractality in hydrology PO4: A research question on multifractality is solved using a new framework PO5: Learned MATLAB software and performed relevant coding PO8: Prepared the manuscript draft adopting ethical principles PO9: Conducted the project work as team PO10: Communicated the work to journal and presented effectively

	part of the final year project		PO12: Showcased the interest for learning interdisciplinary knowledge
Sruthi S, Sreelekshmi C R, Urmila Dileep, Ameesha J Fathima	Connected with Research scholar ; learned coding	Analysing the impact of meteorological drought on crop yield of Kerala, India: a wavelet coherence approach. *Paddy Water Environ* **22**, 313–339 (2024). https://doi.org/10.1007/s10333-024-00969-7	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed the teleconnections between drought and crop yield PO4: A research question on teleconnections of crop yield is analyzed using a new framework PO5: Learned MATLAB software and performed relevant coding PO8: Prepared the report adopting ethical principles PO9: Conducted the project work as team; students were connected with research scholar PO10: Communicated the work to a journal PO12: Showcased the interest for learning interdisciplinary knowledge
Fathima S	Student completed internship at NIT Calicut	Multiscale teleconnection analysis of rainfall patterns over Calicut, India using wavelet coherence	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed the teleconnections of rainfall PO4: A research question on teleconnections of rainfall on local meteorology is analyzed using wavelet PO5: Learned MATLAB software and performed relevant coding PO8: Prepared the internship report and manuscript adopting ethical principles PO10: Communicated the work to a journal PO12: Showcased the interest for learning interdisciplinary knowledge
Akshay sunil, Deepthi B	One student (Deepthi B, 2018)	(i) Modeling future irrigation	PO1: Applied Mathematics, Science, Civil Engineering principles;

	completed UG project and published a research publication from UG. Getting inspired the students later on contacted after Masters, done independent research work and published even during their PhD work progressing at IIT Bombay **(Evidence of life-long learning)**	water demands in the context of climate change: a case study of Jayakwadi command area, India *Model. Earth Syst. Environ.* **7**, 1963–1977 (2021). https://doi.org/10.1007/s40808-020-00955-y (ii) Ranking of CMIP5-Based General Circulation Models Using Compromise Programming and TOPSIS for Precipitation: A Case Study of Upper Godavari Basin, India International Journal of Big Data Mining for Global Warming 2020 02:02, https://doi.org/10.1142/S2630534820500072	PO2: Analyzed the hydrologic problems PO4: Research questions on downscaling is addressed PO5: Proficient in Many software and coding PO8: Prepared the manuscript adopting ethical principles PO9: Conducted the research work as a team PO10: Communicated the work to journals PO12: Showcased the interest in research and engaged in life - long learning
Abhijith S, Abhilash G, Mohamed Sabir	Sustained interest in construction materials and	Paper on "Properties of eco-friendly concrete with partial replacement of fine aggregate with	PO1: Applied Mathematics, Science, Civil Engineering principles PO2: Analyzed problem related

Najeem, Sanjay Krishnan R	technology lead them to End semester project	recycled plastic waste and cement by silica fume", Journal of Emerging Technologies and Innovative Research, ISSN 2349-5162, Volume 11, Issue 2 (2024)	to utilization of recycled plastic waste in making sustainable concrete PO3: Designed a concrete with inclusion of plastic waste and silica fume with appropriate consideration for the public and environment. PO4: Used multiple tests and criteria for the problem, designed experiments, analyzed and interpreted data, to provide valid conclusions. PO6: Addresses a societal problem, followed IS codal provisions for the tests. PO7: Emphatically demonstrated the need for sustainable development by incorporating recycled plastic waste as partial replacement of fine aggregate, and silica fume as mineral admixture. PO8: Prepared the report and presentations adopting ethical principles PO9: Conducted lab analysis and report preparations as a team PO10: Communicated the work effectively through the journal PO12: Showcased the interest for learning new concepts in the broadest context of advancements in concrete technology
Arya C. A.	Started as a mini project and continued the work in her M.Tech	Environmentally Useful Life of Interlocking Concrete Block Pavements: Critical Time Period Concept, J. Sustainable Water Built Environ., 2021, 7(2): 04021001	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem to find the critical time PO4: used multiple criteria for problem analysis PO6: Addresses a societal problem-By suggesting an effective time for relaying the paving blocks PO8: prepared the report adopting ethical principles

			PO10: Communicated the work in the form of a manuscript effectively PO12: Showcased the interest for learning new concepts
Sreelekshmi S, Anakha Remesh, VarshaVenkidesh, Krishna A. J.	End semester project	Paper on 'A hybrid electrocoagulation-biocomposite adsorption system for the decolourization of dye wastewater. Environmental Research 252 (1) 118759, (Elsevier)	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to dye wastewater and its removal PO4: Analyzed the experimental data and interpreted the results PO7: Identified the risk related to dye contamination PO8: Carried out literature review, compiled project report considering ethical principles PO9: Team work was appreciable with good cooperation among team members PO10: Communicated the work as an SCI-indexed journal paper PO11: Identified the various tasks and resources including data and tool for completion of the project PO12: Exhibited the interest to learn new concepts of dye wastewater characteristics and its remediation techniques
Thamanna Rahuman A, Hridya J., Devi P. S., Mariyam Salkka S.	End semester project	Paper on 'Evaluating the performance of electrocoagulation system in the removal of polystyrene microplastics from water' Environmental Research 243 (Elsevier)	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to microplastics and its removal PO4: Analyzed the experimental data and interpreted the results PO7: Identified the risk related to microplastic pollution PO8: Carried out literature review, compiled project report considering ethical principles PO9: Team work was appreciable with good cooperation among team members

			PO10: Communicated the work as an SCI-indexed journal paper PO11: Identified the various tasks and resources including data and tool for completion of the project PO12: Exhibited the interest to learn new concepts of microplastic pollution and its remediation techniques
K. Vidyalashmi, Megha Chandana L, Nandana J. S.	Internship at Tokyo Metropolitan University, Japan End Semester Project	Paper on 'Analysing the performance of the NARX model for forecasting the water level in the Chikugo River estuary, Japan', Environmental Research 251 (Elsevier)	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to water level variations in estuaries PO4: Used multiple scenarios for forecasting water level considering multiple variables and analyzed with interpretation of output PO5: Identified NARX tool, understood its scope and executed analysis PO8: Carried out literature review, compiled project report considering ethical principles PO9: Team work was appreciable with good cooperation among team members PO10: Communicated the work as an SCI-indexed journal paper PO11: Identified the various tasks and resources including data and tool for completion of the project PO12: Exhibited the interest to learn new concepts of estuarine dynamics and new software tool
Shabana Iqbal, A. R. Archana, B. Gopika, Michi Mina		Paper on 'Implications of solid waste dumps on the microplastic abundance in groundwater in Kollam, India' Journal of Environmental Management 348 (Elsevier)	PO1: Applied Mathematics, Science, Civil Engineering principles; PO2: Analyzed problem related to microplastics in groundwater PO4: Analyzed the data and interpreted the results PO5: Identified QGIS as a tool, understood its scope and executed analysis

			PO7: Identified the risk related to microplastic pollution PO8: Carried out literature review, compiled project report considering ethical principles PO9: Team work was appreciable with good cooperation among team members PO10: Communicated the work as an SCI-indexed journal paper PO11: Identified the various tasks and resources including data and tool for completion of the project PO12: Exhibited the interest to learn new concepts of microplastic pollution and the study of tools used for analysis

(ii) Complex Engineering problem solving through Assignment

A situation that a Civil Engineer encounters in the field is framed as an Assignment for the course CEL334 Civil Engineering Software Lab.

Assignment Question

Plan, Analyze, and Design a RCC multistoried structure and prepare structural drawings for the same.

Description of the Assignment

A three-storeyed structure such as a residential apartment, educational institution, hospital or a commercial institution can be taken. The students have to plan and prepare an architectural drawing of the chosen structure using AutoCAD. The students are required to refer to the Kerala Building Rules for selecting suitable areas for different rooms. A structural key plan should be prepared by providing a suitable beam-column layout.

Once the architectural plan and structural key plan have been finalized, the same can be modelled in any analysis software such as STAAD. Suitable loadings are to be provided by referring to IS 875 part 1 and part 2. The same is to be analysed. The students design and detail the critical beam, column, slab and footing. Finally, a project report consisting of the drawings, design and detailing is to be submitted.

Objectives

1. Preparation of architectural plan
2. Preparation of structural key plan by understanding the beam-column layout
3. Analysis and design of RCC multistoried structure using STAAD
4. Preparation of detailed structural drawings
5. Preparation of project report

Program Outcomes Addressed and Justification

PO addressed	Justification
PO1	Application of knowledge of mathematics, engineering fundamentals etc. are required to do the assignment.
PO2	Students are required to come up with their own architectural plan, provide suitable loadings depending on the type of building chosen and understand the analysis of beams, columns, slab and footing.
PO3	The project requires significant knowledge of the Design of reinforced concrete structures. Various components of the building should be designed and detailed properly. The beam-column layout has to be chosen without compromising the strength or space yet providing a cost-effective design.
PO4	Students have to conduct field studies and use various civil engineering codes such as IS 456, IS 875, SP 34 and Kerala building rules for proposing a structurally stable and cost-effective design.
PO5	Significant knowledge on AutoCAD and STAAD is essential for the design and preparation of drawings.
PO9	Since an individual assignment is given to the students, each has to come up with their own solutions. Discussion among their peers is also needed for solving critical situations. This will strengthen their ability to function individually and in teams.
PO10	Students have to prepare detailed structural drawings of the building designed and present it. They also have to prepare a design report of their project.
PO12	Understanding the structural design of a multistoried building and its detailing, the ability to write design report etc. are basic requirements to be a structural engineer. This exercise gives them an opportunity to do the same. Students will be self-motivated to learn many things which they have not learned through classroom academic exercises.