



भारतीय पेट्रोलियम और ऊर्जा संस्थान
INDIAN INSTITUTE OF PETROLEUM AND ENERGY
VISAKHAPATNAM – 530 003

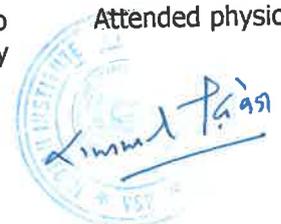
MINUTES OF THE 10TH MEETING OF
THE SENATE, IIPE

Date & Time: 24th April, 2024 (Wednesday) from 1000 hrs;

Venue: IIPE Conference Hall (Room No. 301), IIPE Campus, Visakhapatnam in Hybrid Mode.

Members Present:

1.	Prof. Shalivahan, Director	Chairperson	Attended physically
2.	Prof. Arvind Kumar Mishra, Director, CSIR-CIMFR Dhanbad	Member	Attended physically
3.	Prof. K. Srinivas Reddy, IIT Madras	Member	Attended online
4.	Prof. K. Vijaya Kumar, Dean (Research & Development)	Member	Attended physically
5.	Prof. A. Seshagiri Rao, Assoc. Dean (Faculty Affairs)	Member	Attended physically
6.	Prof. Deepak Amban Mishra Assoc. Dean (Academic Affairs & Admin)	Member	Attended physically
7.	Prof. C.V. Rao, Assoc. Dean (Students' Affairs)	Member	Attended online
8.	Prof. P. Aparoy, Assoc. Dean (Research & Development)	Member	Attended physically
9.	Prof. Sivasankar P., Assoc. Dean (Planning)	Member	Attended physically
10.	Prof. Rajat Jain, Assoc. Dean (IRAA)	Member	Attended physically
11.	Prof. Ranjan Pramanik, Assoc. Dean (IIE)	Member	Attended online
12.	Prof. Himangshu Kakati PIC-Examinations & HoD Petroleum Engineering	Member	Attended physically
13.	Prof. P. Venkata Reddy, HoD, Chemical Engineering	Member	Attended physically
14.	Prof. Arun Kumar Pujari, HoD, Mechanical Engineering	Member	Attended physically
15.	Prof. Somnath Ghosh, HoD, Humanities & Sciences	Member	Attended online
16.	Prof. R. Ramunaidu, Dept. Humanities & Sciences	Member	Attended physically
17.	Prof. T. Hemanth Kumar, Dept. Chemical Engineering	Member	Attended physically
18.	Prof. Raka Mondal, Dept. Chemical Engineering	Member	Attended online
19.	Prof. Dipankar Pal, Dept. Chemical Engineering	Member	Attended physically
20.	Shri Ram Phal Dwivedi, Registrar	Ex-officio Secretary	Attended physically



At the outset, the Chairman welcomed all the members of the Senate. After ascertaining the requisite quorum, the Chairman declared the meeting open.

The following agenda was transacted.

Senate/10/01	Confirmation of the Minutes of the 8th & 9th meetings of the Senate held on 26.05.2023 and 07.07.2023 respectively.
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The Minutes of the 8th meeting of the Senate of IPE held on 26.05.2023 were circulated to all the learned members of the Senate through email on 16.06.2023. There were no comments/ remarks received from the members either by email or on the floor.

The Minutes of the 9th meeting of the Senate held on 07.07.2023 were circulated through email on 07.07.2023. There were no comments/ remarks received from the members either by email or on the floor.

The Senate was requested to confirm the minutes of the 8th and 9th meetings.

Resolution: The Senate resolved to confirm the Minutes of the 8th & 9th meetings of the Senate, held on 26.05.2023 and 07.07.2023, respectively.

Senate/10/02	Submission of Action Taken Report on Minutes of the 8th & 9th meetings of Senate, IPE.
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The Action Taken Report (ATR) on the Minutes of the 8th & 9th meetings of the Senate presented before the members. The Senate noted the same with satisfaction.

Senate/10/03	Director's Report on the progress of various activities of the Institute.
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The Director presented the following on the progress of various activities of the Institute since the last meeting of the Senate.

At the outset, the Director expressed his gratitude to the Senate members for their contributions to the academic and research endeavors at IPE. The following are further reported:

(i) The Bhoomi Poojan (Ground Breaking Ceremony) of the Institute was performed by the Hon'ble Prime Minister Shri Narendra Modi on 02nd March 2024, through video conference in the presence of the Hon'ble Union Minister for Petroleum and Natural Gas & Housing and Urban Affairs Shri Hardeep S Puri from Ula, Begusarai, Bihar. Shri. Pankaj Jain, Secretary, MoP&NG, GoI, and Prof. Shalivahan, Director, IPE, were also present at the event. A diverse array of more than 500 individuals including public representatives, distinguished guests, government officials, the IPE fraternity, representatives of press and media, and other stakeholders witnessed virtually the Bhoomi Poojan Ceremony at the permanent campus site. During the AY 2023-2024, the Institute introduced B.Tech. (Mechanical Engineering) and M.Sc. (Applied Geology) and admissions of 22 Industry-sponsored Ph.D. students.

(ii) During the AY 2023-24, the Institute introduced B.Tech. (Mechanical Engineering) and M.Sc. (Applied Geology) and conducted admissions for 22 Industry-sponsored Ph.D. students.

(iii) As of date, there is a total of 41 final-year B.Tech. students placed out of 47 students who opted for placements, with an average CTC of Rs. 10 Lakhs (aprox.) and with a maximum CTC of Rs. 21.00 Lakhs (approx.). The Senate members acknowledged the efforts of the CDC team in this regard.



(iv) The Institute has 18 ongoing research projects with a total outlay of Rs. 45.20 Crores. During the F.Y. 2023-24, 12 projects with an amount of Rs. 38.64 Crores have been sanctioned to the faculty by various research sponsoring agencies, including a research project from NTPC for installing a Green Hydrogen Plant for 1 TPD hydrogen generation from seawater. Institute is now a part of SPARC and GIAN. Unfortunately, as per FIST-2024, "... Educational organizations under the aegis of other Ministries/ Depts./ Agencies are excluded from the scope of FIST 2024 support..". We have requested DST for inclusion of IIPE, but their response is still pending. The Senate thanked the Dean (R&D) and the team for securing the research projects.

(v) During the year 2023-24, a total of 42 publications were made as research articles, Book Chapters, Books, and Conference Papers by the faculty members. The Director informed that the faculty members filed applications for 04 patents.

(vi) He extended gratitude to the Dean (Planning) and Institute Works Committee (IWC) for their impetus efforts in the construction activities of the permanent campus. He hoped that the construction of the Permanent Campus would be within the timeline.

(vii) The Institute signed MoUs with the University of Houston (UoH), USA; University of Stony Brook, USA; Ufa State Petroleum Technological University; Sharif University of Technology (SUT), Tehran for academic and research purposes and Environmental Management & Systems Engineering Lab (EMSEL), Kyung Hee University, Korea for Environment, Energy Research, Education and Management. The MoU with the University of Houston was signed on 15.01.2024 in the presence of Shri Pankaj Jain, Secretary, MoP&NG, GoI.

(viii) The Institute also signed MoUs with M/s. Greenko Foundation to support M. Tech. students for Fellowships and internships at their plant and possible placements; G-TEC, GITAM Deemed to be University for R&D Collaboration; M/s Parking Consultants, Hyderabad for skill development, training, and industry collaboration; Oil India Limited for R&D Interactive Programme; CSIR-Central Institute of Mining and Fuel Research for co-operation in the fields of education, training and research in emerging areas of the energy sector; Petroleum and Explosives Safety Organization for training for skill development for safety in industries-interaction/ co-operation.

(ix) The Institute hosted its first Foreign Researcher Dr. Jan Friedrich, Aachen University, Germany. The Senate appreciated the host Faculty, Prof Samala Rathan for hosting the foreign researcher.

(x) **The Institute has organized the following seminars/ workshops/ conferences:**

(a) **Hydrogen Summit:** A 3-day Global Energy Environment Summit focusing on Hydrogen, namely 'Hydrogen Energy Resource & Opportunity (HERO) 2023', was conducted from 24th – 26th July 2023. Shri Pankaj Jain, the Secretary of the Ministry of Petroleum and Natural Gas, Government of India, was the Chief Guest and delivered the Keynote Address.

(b) **REUSG-2023:** A 2-day workshop on 'Renewable Energy Utilization for Sustainable Growth' was organized from 25th – 26th August 2023 at the Institute to discuss challenges associated with renewable energy generation and its utilization. The primary focus is on technologies that can improve efficiency, reduce emissions, and bring sustainability to the energy sector's growth. Prof. K. Srinivas Reddy, Department of Mechanical Engineering, IIT Madras, was the Chief Guest for the event.



(c) **EBLT-2024:** The Institute conducted a two-day national-level conference on 'Evidence-Based Library Transformations: Quality Services for NextGen Users (EBLT-2024)' from January 24-25, 2024. Dr. Mahendra Jadhav, Librarian, IIT Madras, and Dr V. K. Jagjeevan, Librarian, IGNOU New Delhi, were the conference's Chief Guest and Guest of Honour, respectively.

(d) **EE&MM-2024:** A two-day national conference on 'Earth's Materials for Energy: Mantle to Market (EE&MM-2024)' was organized during February 1-2, 2024, at the Institute. The conference's key themes were about natural resources the Earth provides for energy purposes, encompassing hydrocarbons, nuclear fuels, white hydrogen, and geothermal energy. Prof Saibal Gupta, Department of Earth Science, IIT Kharagpur and Dr Kaustav Nag, ADG (Exploration), DGH, were the Chief Guest and Guest of Honour for the Conference, respectively.

(e) **ChemEEE-2024:** The Institute organized the International Conference on 'Trends in Chemical, Energy and Environmental Engineering (ChemEEE-2024)' conference during February 19-21, 2024, at Visakhapatnam with emphasis on the importance of the energy transition and role of start-ups in job creation. Prof. Suddhasatwa Basu, IIT Delhi, and Former Director CSIR-IMMT Bhubaneswar, was the chief guest at the event.

(f) **Webinar on Unconventional Hydrocarbon Resources: Opportunities and Challenges:** The Institute organized a two-day webinar on Unconventional Hydrocarbon Resources: Opportunities and Challenges from March 28-29, 2024, for the students of Khazar University, to provide knowledge on petroleum exploration to production activities to provide a complete overview of the increasingly complex operations in oil and gas industry.

(g) **Events:** The Institute has organized other events for students such as Techno-Cultural Fest-Shaswat 2K23; Freshers' Day-'Croeso-7.0', Institute's Foundation Day, Independence Day, Republic Day, National Sports Day; Intra Sports Meet-2023, etc. during the year.

(h) The Department of Chemical Engineering conducted a Certificate Program on Machine Learning.

Director thanked faculty members for their efforts in organizing the events successfully. He informed the Senate that plans were made to conduct at least one monthly outreach activity. The Senate appreciated the efforts made by the Institute.

(x) **3rd Convocation:** The Institute conducted the 3rd Annual Convocation on 05th August, 2023. Prof. Archana Bhattacharyya, Indian National Science Academy Honorary Scientist and former Director, Indian Institute of Geomagnetism, Government of India attended as the Chief Guest.

Senate/10/04	Conferment of degree of Bachelors of Technology (B.Tech.) to 58 students.
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The Senate was apprised that a total of 58 B.Tech. students have successfully completed their Course of study in the academic year 2023-24. Among them, 32 students were from the Chemical Engineering and 26 students were from the Petroleum Engineering. The list of 58 students, placed in the Senate are as follows:



Chemical Engineering			Petroleum Engineering		
Sl.No.	Roll No.	Student Name	Sl.No.	Roll No.	Student Name
1	20CH10001	Srishti Shreya	1	20PE10001	Baddila Likhith
2	20CH10002	Vikash Singh Rathore	2	20PE10002	Priyanshu Kumar Singh
3	20CH10006	Ankita Chakraborty	3	20PE10004	Hare Krishna Harshit
4	20CH10007	Tata Sai Siva Kiran	4	20PE10008	P N Harshitha
5	20CH10009	Hisham Kurikkal M T	5	20PE10010	Yalla Pavan Tanoj
6	20CH10010	Arihant Jain	6	20PE10013	Pranav K S
7	20CH10013	Rishikesh Rishu	7	20PE10014	Vivek Kumar Mahto
8	20CH10014	Adithyan B	8	20PE10015	M Adharsh
9	20CH10015	Dheeraj Kumar Sharma	9	20PE10017	Saurabh Kumar
10	20CH10016	Shubham Thukran	10	20PE10019	Sardar Ganesh Raj
11	20CH10017	G Tarun Rao	11	20PE10021	Pranjal L Pachbiye
12	20CH10018	Hitesh Kumawat	12	20PE10022	Aayushi Jagat Gangwar
13	20CH10020	Parag Daharwal	13	20PE10023	Shubham Kumar
14	20CH10021	Abdul Rahman S	14	20PE10024	Shashwat Garg
15	20CH10025	Chavali V K Jagannadh	15	20PE10027	Abhishek Raj
16	20CH10028	Aayush Dwivedi	16	20PE10028	Priyanshu Gahtori
17	20CH10029	Aman Bhaskar	17	20PE10029	Sthitadhi Maitra
18	20CH10030	Shaik Abdul Kalam	18	20PE10031	Rahul Prasad Iyer
19	20CH10032	Ankit Kumar Jangir	19	20PE10033	Bhosale Abhinav Tryambakrao
20	20CH10033	Aryan Singh	20	20PE10039	Lokendra Pachauri
21	20CH10036	Soumyadeep Adhikary	21	20PE10044	Nakul Sanadhya
22	20CH10040	Pramod Kumar	22	20PE10050	Prakhar Goyal
23	20CH10041	Valluri Gnanendra Pratap	23	20PE10051	Deepak Kumar
24	20CH10042	Yogesh Sisodiya	24	20PE10059	Dokku Sai Maruthi
25	20CH10044	Ishan Chaturvedi	25	20PE10062	Ashwini Kumar
26	20CH10045	Pandey Vishal Jitendra	26	20PE10064	Aditya Rai
27	20CH10046	Abhijeet Sinhasane			
28	20CH10048	Rohit Kumar			
29	20CH10051	Dinesh Kumar Dasari			
30	20CH10052	Ayush Ranjan			
31	20CH10053	Kumar Saurav			
32	20CH10056	Pratyush Bhatt			

The Senate was requested to consider the same and to recommend for approval of the Board for conferment of the degree of B.Tech. to the 58 students in the upcoming 4th Convocation.

Resolution: Resolved to recommend a total of 58 B.Tech. students who have completed their Course of study in the academic year 2023-24 for conferment of the degree of B.Tech. in the upcoming 4th Convocation, for the approval of the Board.



Senate/10/05	Conferment of President Gold Medal, Institute Gold Medal and Institute Silver Medal.
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The Senate was apprised that IIFE confers the Institute Gold Medal and Silver Medal to the academic toppers in each branch of the graduating batch and the President's Gold Medal to one student for the best all-around performance from the graduating batch.

In this regard, the Institute constituted a committee to select an eligible student for conferment of the President Gold Medal. The recommendations of the Committee were placed before the Senate for consideration.

The list of recommended students for the conferment of medals for the 2024 graduating batch is given below:

- | | |
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| (i) President's Gold Medal | - Ms. Aayushi Jagat Gangwar (20PE10022) |
| (ii) Institute Gold Medal (Che. Engg.) | - Mr. Abdul Rahman S. (20CH10021) |
| (iii) Silver medal (Che. Engg.) | - Mr. Ayush Ranjan (20CH10052) |
| (iv) Institute Gold Medal (Petro. Engg.) | - Mr. B. Abhinav Tryambakrao (20PE10033) |
| (v) Silver medal (Petro. Engg.) | - Ms. Aayushi Jagat Gangwar (20PE10022) |

Resolution: Resolved to recommend the list for conferment of medals for the approval of the Board.

Senate/10/06	Introduction of Web-Based M. Tech. Programs.
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The Institute proposed to initiate Web-Based M.Tech. Programs for industry professionals. The detailed proposal and requisite qualifications, fees, and remuneration for involved faculty were presented before the Senate for its recommendations.

Resolution: The proposal was deliberated in detail and the Senate resolved to recommend the Web-Based M.Tech. Programs for implementation from AY 2024-25 as per guidelines placed at **Annexure-1**, for approval of the Board.

Senate/10/07	Introduction of Web-Based M.Tech. Programs in Data Sciences and Machine Learning, and Sustainable Energy
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The Senate was apprised on the proposal to initiate Web-Based M.Tech. Program from the Academic Year 2024-25 in

- (i) Data Sciences and Machine Learning; and
- (ii) Sustainable Energy.

The Director informed that the Web-Based M. Tech. in Sustainable Energy course structure is being prepared in consultation with M/s Greenko.

The detailed course structure of the Data-Science and Machine Learning was presented before the Senate (**Annexure-2**) for its recommendations.

Resolution: The Senate recommended the Course Structure of Data Science and Machine Learning for the Web-Based M.Tech. Program, for the approval of the Board. The Senate further authorized the Chairman, Senate to put up the course structure for Web-Based M. Tech. in Sustainable Energy to the Board for its approval and to report it in the next Senate Meeting.



Senate/10/08	Introduction of a new B.Tech. Program in 'Mathematics and Computing' from the A.Y. 2024-25.
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The proposal to introduce a new B.Tech. Program in Mathematics and Computing, along with the course structure (**Annexure-3**), has been placed before the Senate for its recommendations.

Resolution: The proposal was deliberated in detail, and the Senate decided to recommend the same for the commencement of the Program from the Academic Year 2025-26, for approval of the Board. Additionally, the Senate suggested for verification of the Program's credits compared to those of other existing programs as per Institute norms and for placing before the Senate in the next meeting for its recommendation.

Senate/10/09	Ph.D. for Foreign Nationals.
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Based on the recommendations of the Senate during its 6th meeting held on 22.08.2022, the Ph.D. program for foreign nationals as full-time students was approved by the Board. In this regard, the Committee's recommendations for preparing guidelines have been placed before the Senate. The Senate deliberated and suggested on the execution of the proposal and proposed fee structure as follows:

- a) Renaming the Program as "External Ph.D. for National and International Students including OCI/NRI/PIO";
- b) In the case of an External Ph.D., it is preferred to have a Co-Guide from the candidate's industry or Institute;
- c) No Institute fellowship will be provided for External Ph.D. for both national and foreign national candidates.

The following fee structure for foreign nationals, including OCI/NRI/PIO candidates:

At the time of admission	Registration Fee, Tuition Fee, Convocation Fee, Alumni Subscription Fee, Thesis Evaluation Fee, Student Brotherhood Fund, Modernization Fee, Library Fee	1000 USD
Semester Fee	Registration Fee, Library Fee, Laboratory Fee, Tuition Fee, Institute Development Fee	700 USD

Resolution: The proposal was deliberated in detail, and the Senate resolved to recommend the same for approval of the F.C./ Board:

Senate/10/10	New courses for PhD students and U.G. elective syllabus
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The Institute has proposed new courses for PhD and Undergraduate Mechanical Engineering and Chemical Engineering students. The detailed syllabus for the proposed courses/ electives has been placed before the Senate (**Annexure-4**) for consideration and approval.

Resolution: After detailed deliberations, the Senate resolved to approve the same for implementation from the academic year 2024-25.



Senate/10/11	UG/PG Dissertation Guidance
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It was proposed that along with a Supervisor from the Institute, an additional Supervisor from outside the Institute/ Country may also be allowed with the approval of the DoAA/Director for UG/PG Dissertation Guidance. The Senate was requested to approve the proposal.

Resolution: After detailed deliberations, the Senate resolved to approve the proposal effective from the academic year 2024-25.

Senate/10/12	Guidance on applying a late fee for the semester registration after the notified deadline.
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A committee was constituted to make necessary recommendations for the applicable late fee for the semester registration by the student after the notified deadline. The recommendations of the Committee were placed before the Senate for guidance and its recommendations.

The proposal was deliberated in detail, and the Senate resolved to recommend the following late fee for the semester registration after the notified deadline from the AY 2024-25:

- (i) Up to 07 days from the notified deadline: Rs. 500/-;
- (ii) From 08-14 days from the notified deadline: Rs. 1000/-;
- (iii) From 15th day of the notified deadline to till the day before the start of mid-semester examinations: Rs. 2500/-;
- (iv) Students will be de-registered for the semester once mid-semester examination starts.

Resolution: The proposal was deliberated in detail, and the Senate resolved to recommend the same from the AY 2024-25, for approval of the F.C./ Board

Senate/10/13	Any other agenda with the permission of the Chair.
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The following agenda was transacted with permission of the Chair.

Senate/10/13(i)	Fees for internal staff members on joining various academic courses at IIPE.
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A committee was constituted to make suitable recommendations about fees for internal staff members who are joining various academic courses offered at IIPE. The Committee's recommendations were placed before the Senate for its consideration. The proposal was deliberated in detail, and the Senate resolved to recommend the following:

- (a) Only permanent and confirmed Institute staff members are permitted to join the PhD Programme. However, they must get prior approval before applying for the PhD Programme. They would be treated as a Part-Time PhD Scholar.
- (b) A member of staff enrolled for the Ph.D. degree shall be required to pay only Admission Fees, Thesis Evaluation, Convocation Fees, Semester Registration Fees and Examination Fees as applicable to Sponsored category.



(c) All rules applicable for Part-Time PhD Scholar related to course work, prosecution of research work under the supervision of a member of faculty, etc., shall apply to all staff members when enrolled.

(d) An Employee who is awarded a PhD degree, must be engaged in the institute development in the form of knowledge-sharing process for at least a minimum period of 3 years from the date of award of Degree. If any employee wishes to leave the Institute during study or within a period of 03 years after attaining a research degree, the amount equivalent to tuition fees till the duration of the Course shall be deposited subject to fulfilling the other norms of the Institute. The Employee has to furnish a bond in the form as prescribed by the Institute, in this regard.

(e) A Committee may be constituted to look into the possibility of the Employees' wards to pursue Degree at IIPE.

Resolution: After detailed deliberations, the Senate resolved to recommend the same for approval of the F.C./ Board.

Senate/10/13(ii)	Appeal from Mr. J.D. Sandeep, Roll No: 21CH10030
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An appeal was received from Mr. J.D. Sandeep, Roll No: 21CH10030 (**Annexure-5**), to reconsider the decision made by the Grievance Committee pertaining to his unfair means during the end-semester examinations. In this regard, the decision of the Grievance Committee, along with the student request, has been placed before the Senate for consideration.

Resolution: After detailed deliberations, the Senate resolved to accept the request made by Mr. J.D. Sandeep and permitted to attend the supplementary examinations conducted by the Institute except for Laboratory Classes, as a one-time measure and subject to any other restriction/ conditions imposed by the Institute thereafter. Further, the Senate suggested that a Committee may be constituted to re-look into the existing guidelines for initiating the disciplinary action against students involved in unfair means during examinations.

Senate/10/13(iii)	Proposal to modify the eligibility criteria for admission to the Ph.D. program.
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The Senate was apprised of a proposal to review the eligibility criteria for admission to the Ph.D. program, i.e., allowing candidates with an M.Tech. Degree in engineering or technology after qualifying for a GATE and is also eligible for an Institute Research Assistantship, which was approved by the Chairman of the Senate on 28.03.2024 (**Annexure-6**).

In this regard, the Senate was requested to ratify the decision of the Chairperson, Senate.

Resolution: Resolved to ratify the decision of the Chairperson, Senate.

Senate/10/13(iv)	Approval for change of a supervisor for Ph.D. research scholar Mr. Tenneti Srinivas, Roll No: 24RS9004
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It was reported that the Chairperson, Senate approved for a change of Supervisor in respect of a Research Scholar Mr. Tenneti Srinivas, Roll No. 24RS9004, based on the individual request.

The members of the Senate noted the same.



Senate/10/13(v)	Notification for Branch Change for the Academic Year 2024-25
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It was reported that considering the enrollment status of the students for 2023-24 batch and as per extant guidelines of the Institute, the notification for branch change for students was not considered by the Institute for the academic year 2024-25.

Resolution: The members of the Senate noted the same.

Senate/10/13(vi)	Proposal for renaming the 'Institute Research Assistantship' as 'Institute Research Fellowship'
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A proposal was placed before the Senate for change of name of the 'Institute Research Assistantship' as 'Institute Research Fellowship' as existed in other CFTIs.

Resolution: The Senate has resolved to approve the change of name of the 'Institute Research Assistantship' as 'Institute Research Fellowship' with immediate effect.

The meeting ended with thanks to the Chair.

May please be approved.

Amit Singh
Registrar & Ex-officio Secretary, Senate
10.05.2024

APPROVED

[Signature]
10/05/2024
Director & Chairman, Senate





INDIAN INSTITUTE OF PETROLEUM AND ENERGY

VISAKHAPATNAM – 530 003

Web-Based M. Tech Program

The Web-based M. Tech Program ensures that professionals gain relevant and up-to-date knowledge. Industry professionals generally pursue further education while working full-time. This specialized *M.Tech program for professionals offers flexible scheduling options, such as evening/weekend classes*, allowing individuals to balance their work and academic commitments. Further, such a program brings together industry professionals from diverse backgrounds and organizations. This provides valuable networking opportunities, allowing professionals to exchange ideas, collaborate on projects, and build relationships within their Industry. Completing such an M.Tech program can enhance career prospects and open up new opportunities for advancement within the Industry. Employers often value advanced degrees and specialized skills, recognizing the commitment to continuous learning and professional development. The Program can offer a curriculum specifically tailored to the needs of the Industry, covering topics such as emerging technologies, industry trends, regulatory requirements, and best practices to ensure graduates are well-equipped to address the challenges and demands of their profession.

A Web-based M.Tech program for industry professionals can provide targeted education, practical experience, and networking opportunities essential for career advancement and success in today's competitive job market.

Program Details

Courses (Core and Elective)	Nine courses, each of three credits, with a total of 27 credits
Thesis Unit	Six courses, each of three credits, with a total of 18 credits
Total Credits	45 Credits for award of M.Tech. Degree

The first three semesters encompass core and elective courses, leading to project work in the subsequent semesters. The admitted students must complete the Thesis Unit (Project Work) at their respective Organizations. The course is designed as an online program tailored for Industrial Professionals, with final exams necessitating physical attendance. The courses may include international and industrial electives. No Ph.D. Course waivers will be granted for candidates enrolled for Web-Based M.Tech. Program. Ph.D. Course waiver requests may be considered solely for Integrated Ph.D. programs (M.Tech.+Ph.D.)

Duration

A maximum of three Courses can be registered each semester. The maximum duration of the Program is seven semesters. The Thesis Unit can be taken only after completing the coursework. The Institute Faculty and Industry Professionals may jointly supervise the project work. These candidates must have a Supervisor (Internal) from IIPE and an External Supervisor (Optional) from their parent organization where employed for the Thesis Unit.

In line with the **NEP-2020**, the Web-Based M. Tech has a Multiple Exit Option.

- (a) **Exit Option 1:** Completion of all theory courses of the first semester (Nine Credits) will lead to a Certificate course named 'Web-Based Certificate Course (Programme Name)';



Abhinav Kan
24.04.2024

- (b) **Exit Option 2:** Completion of all the First Two Semester courses (Eighteen Credits) will lead to a Certificate course named 'Web-Based Certificate Course (Programme Name)'
- (c) **Exit Option 3:** Completing all Nine Theory Courses (Twenty-Seven) will result in a Web-Based PG Diploma (Course Name).
- (d) Completing 45 Credits (27 Credits for Theory and 18 Credits for Thesis Unit) will lead to a Web-Based M. Tech (Programme Name).

Program Approval

IIPE is an institution of national importance that enjoys autonomous status under the Ministry of Petroleum and Natural Gas, Government of India. Though this Program is an online degree program, it is approved and offered within the Institute's charter. The UGC/AICTE guidelines do not apply to this Program. The Program and degree are and will remain valid.

The Programme's minimum enrolment threshold has been set at five students, while the maximum capacity is capped at thirty students. Admissions will be conducted once annually to maintain consistency and efficacy.

QUALIFICATION AND EXPERIENCE

Qualification: Bachelor's Degree (4 years program) or a Masters Degree with at least 55% marks (without round-off) or 5.5/10 CGPA (without round-off).

Experience: Minimum of One year of work experience. Candidates with relevant experience will be preferred.

Selection: Selection will be based on a written test/interview conducted online by the Institute.

Fees

Application Form Fees: Rs. 1000/- or as decided by the Director from time to time.

Admission Fees: Rs. 50000/-.

The fee for the Program is Rs. 30000/- (Excluding Applicable Taxes) per course.

Fee-Waiver

IIPE Online Masters program offers incentives in the form of discounts to employees of government, defense, PSU, MSME, and other corporate employees. The concerned entity (Department/PSU/MSME/ Corporate) must agree with IIPE or provide a formal/written document when sponsoring/nominating students for the Online Masters Programme. Table 1: Employees of Government, PSUs, or Defense Departments.

SNo	Category	Nominated/Sponsored*	Max Applicable Fee Waiver for Web-Based M. Tech Only
1	Defense Personnel/ PSU/Govt. Depts/CFTIs	Sponsored	Fee waiver of Three Courses



2	Defense Personnel/ PSU/Govt. Depts/CFTIS	Nominated	Fee waiver of Two Courses
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*The above waivers are applicable even if one candidate is nominated/sponsored by the concerned entities. Government includes constitutional bodies as well as non-constitutional bodies (i.e., all statutory, regulatory, and executive bodies) like Finance Commission, UPSC, SEBI, TRAI, CERC/SERCs, RBI, FSSAI, NHB, Niti Ayog, CBI etc.

Table 2: Employees of Private Entities (MSME'S/Corporates)

Sno	Category	Min No. of Students#	Max Applicable Fee Waiver for Web-Based M. Tech Only
1	MSME	3	Fee waiver of the last two modules
2	Other Corporates	5	Fee waiver of the last two modules

#The above waivers are applicable only if the minimum number of candidates are sponsored/ nominated by the concerned entities.

***Nominated:** Refers to candidates nominated by the concerned entity but who are self-funded.

***Sponsored:** Refers to candidates whose fee is funded by the concerned entity. Please note for sponsored candidates whose fees are directly paid by an organization.

Please note: The Institute reserves the right to modify, amend, or discontinue any discount program at any time. All decisions made by the Institute regarding discounts are final. There is no appeals process, and the Institute is under no obligation to provide explanations for its decisions.

Refund of Fees

- Application Fee Non-Refundable.
- 90% of the Admission Fee and the entire course fee is Refundable before the start of the Program. After the start of the Program, no fee is refundable. No fee is transferrable.

Remuneration

- The course taught in this course will not be treated as the teaching load. The faculty members may be paid a remuneration of 20% of the Course Fee up to a maximum of Rs. 1,00,000/-. The said amount will be credited to the Professional Growth Fund of the Individual Faculty.
- 100 US Dollars per hour for International faculty and Rs. 1,00,000/- for Industry Experts per course.
- No remuneration for guiding Project.
- Classes will generally be held on Weekdays from 6 PM to 8 PM and Saturdays from 10 AM to 1 PM.


 24/04/2024
 REGISTRAR
 INDIAN INSTITUTE OF PETROLEUM & ENERGY
 VISAKHAPATNAM



COURSE STRUCTURE and SYLLABUS

for

Online M. Tech in Data-Science & Machine Learning

Indian Institute of Petroleum and Energy

Visakhapatnam, Andhra Pradesh - 530003



Agenda: Proposal to start Online M. Tech in Data Sciences & Machine Learning at IPE, Visakhapatnam.

Overview:

Organizations are increasingly relying on data-driven insights to make informed decisions, creating a strong demand for professionals with expertise in these areas. There is a significant demand for data scientists and machine learning engineers across various industries.

The skills learned in data science and machine learning are applicable across various industries and domains to analyze customer behavior, optimize business processes, or develop recommendation systems. Individuals with these skills can contribute to cutting-edge technological developments and advancements in artificial intelligence, predictive analytics, natural language processing, and computer vision.

This program is aimed at Software and IT professionals seeking to transition to Data Scientist or Data Engineer roles. Software and IT professionals can pursue the program without any career break. The classes are conducted beyond office hours and on weekends.

Several IITs, NITs, and IIITs have recently started offering programs to fill the vacuum and meet the growing need for a trained workforce in this area. Along with the national institutes, IPE, Visakhapatnam would like to fill part of the ever-increasing demand by introducing a 3-4 years online M. Tech. in Data Science and Machine Learning program. This program allows working IT professionals to gain the skills needed to work as a Data Engineer or a Data Scientist. The curriculum was designed to provide a solid theoretical foundation and good hands-on exposure.

To summarize, the program aims to transform current IT professionals into the future workforce who can solve the industry and research problems in the Data Science and Machine Learning domain. Intake of the students for this programme in the upcoming academic year 2024-25 is as follows:

S. No	Online PG programme	Duration	Total intake
1.	Online M. Tech in Data Sciences & Machine Learning	Self-paced over 3 – 4 Years	--



1. Eligibility Criteria and Admission Process

Eligibility:

- Employed professionals holding B.E. / B.Tech. with at least 60% aggregate marks and minimum one-year work experience after the completion of the degree are eligible to apply.
- Employed professionals holding MCA / M.Sc. or equivalent with at least 60% aggregate marks with university level mathematics / statistics as mandatory subjects and minimum one-year work experience after the completion of the degree are also eligible to apply.

Selection Procedure:

The selection will be based on written tests/ interviews.

Program fee:

For each 3 -credit course, Rs. 30,000.00/- and for each 9-credit course Rs. 60,000.00/- will be charged. In summary, the total cost of course is Rs. 3,90,000.00/-

2. Degree Requirements: The candidate must complete a minimum of 45 credits for award of course completion certificate.

Mode of the course: The courses would be offered on weekends from 9:00 AM – 5:00 PM. The courses will be held online. The end-semester exams typically happen in the campus. Hence, the students might be required to travel to IIFE once at the end of each semester in which she/he has taken a course.



Course curriculum

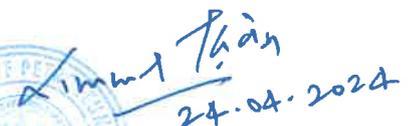
SEMESTER – I						
Sl. No	Code	Course Name	L	T	P	Credit
1		Mathematical foundations of Data Science	3	0	0	3
2		Introduction to Statistical Techniques	3	0	0	3
3		Python Programming for DS	3	0	0	3
Total			9	0	0	9

SEMESTER - II						
Sl. No	Code	Course Name	L	T	P	Credit
1		Machine learning & its applications	3	0	0	3
2		Optimization	3	0	0	3
3		Data Structures & Algorithms	3	0	0	3
Total			9	0	0	9

SEMESTER - III						
Sl. No	Code	Course Name	L	T	P	Credit
1		Deep learning	3	0	0	3
2		Elective	3	0	0	3
3		Elective	3	0	0	3
Total			9	0	0	9

SEMESTER – IV						
Sl. No	Code	Course Name	L	T	P	Credit
1		Project	9	0	0	9
Total			9	0	0	9

SEMESTER – V						
Sl. No	Code	Course Name	L	T	P	Credit
1		Project	9	0	0	9
Total			9	0	0	9


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POSSIBLE ELECTIVES*						
Sl. No	Code	Course Name	L	T	P	Credit
1		Reinforcement learning	3	0	0	3
2		Natural language processing	3	0	0	3
3		Image processing	3	0	0	3
4		Time series analysis	3	0	0	3
5		Bioinformatics	3	0	0	3
6		Computational methods for DE & applications	3	0	0	3
7		Numerical Linear Algebra	3	0	0	3
8		High performance computing	3	0	0	3
9		Graphs & Algorithms	3	0	0	3
10		Big data Analytics	3	0	0	3

*Electives will be floated according to the availability of the subject expert from time to time.



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Semester - I

Course Type	Code	Name of Course	L	T	P	Credit
Core		Mathematical foundations of Data Science	3	0	0	0

Syllabus

Basics of Data Science: Introduction; Typology of problems; Importance of linear algebra, statistics and optimization from a data science perspective; Structured thinking for solving data science problems.

Linear Algebra: Matrices and their properties (determinants, traces, rank, nullity, etc.); Eigenvalues and eigenvectors; Matrix factorizations; Inner products; Distance measures; Projections; Notion of hyperplanes; half-planes.

Probability, Statistics and Random Processes: Probability theory and axioms; Random variables; Probability distributions and density functions (univariate and multivariate); Expectations and moments; Covariance and correlation; Statistics and sampling distributions; Hypothesis testing of means, proportions, variances and correlations; Confidence (statistical) intervals; Correlation functions; White-noise process.

Optimization: Unconstrained optimization; Necessary and sufficiency conditions for optima; Gradient descent methods; Constrained optimization, KKT conditions; Introduction to non-gradient techniques; Introduction to least squares optimization; Optimization view of machine learning.

Introduction to Data Science Methods: Linear regression as an exemplar function approximation problem; Linear classification problems.

Text Books/ Reference:

1. G. Strang. Introduction to Linear Algebra, Wellesley-Cambridge Press, Fifth edition, USA, 2016.
2. Bendat, J. S. and A. G. Piersol. Random Data: Analysis and Measurement Procedures. 4th Edition. John Wiley & Sons, Inc., NY, USA, 2010
3. Montgomery, D. C. and G. C. Runger. Applied Statistics and Probability for Engineers. 5th Edition. John Wiley & Sons, Inc., NY, USA, 2011.
4. David G. Luenberger. Optimization by Vector Space Methods, John Wiley & Sons (NY), 1969.



Kimuraj P. J.
24.09.2024

5. Cathy O'Neil and Rachel Schutt. Doing Data Science, O'Reilly Media, 2013.

Course Type	Code	Name of Course	L	T	P	Credit
Core		Introduction to Statistical Techniques	3	0	0	0

Syllabus

Sampling distributions: Chi-square, t and F distributions, random sample, sample mean and sample variance, the central limit theorem, distributions of the sample mean and the sample variance for a normal population

Estimation: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for properties, problems

Testing of Hypotheses: Null and alternative hypotheses, the critical and acceptance regions, two types of errors, power of the test, the most powerful test and Neyman-Pearson fundamental lemma, tests for one sample and two sample problems for normal population (t, F, Z tests), tests for proportions, Chi-square goodness of fit test and its applications, problems.

Regression Analysis: Simple linear regression (Description of the model, Least squares estimation, properties of the least square estimators, confidence interval and hypothesis testing for the model parameters, correlation); Multiple linear regression model (Description of the model, matrix approach of Least squares, properties of the least square estimators, confidence interval and hypothesis testing for the model parameters)

Text Books/ Reference:

1. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier.
2. J. S. Milton & J. C. Arnold, Introduction to Probability and Statistics, McGraw Hill.
3. D C Montgomery, Design and Analysis of Experiments, Wiley 2014.
4. Alexander Mood, Franklin Graybill D. Boes, Introduction to the theory of Statistics, McGraw Hill



Kimul Singh
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core		Python Programming for DS	3	0	0	3

Syllabus

Introduction to Python: Install Python and Environment Setup, Python Identifiers, Keywords and Indentation, Getting User Input, Python Data Types, Control Statements, Functions, Modules, Packages, List, Tuples, Dictionaries, and Sets. File I/O, Exception handling, Python Object Oriented, Python Multithreaded Programming. Data Science libraries: NumPy, Pandas. Data Visualization.

Text Books/ Reference:

1. Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 2nd Edition, No starch Press, 2019.
2. Martic C Brown, Python: The Complete Reference, 4th Edition, McGraw Hill Publishers, 2018.
3. Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem Solving Focus, 2nd Edition, Wiley India Edition, 2017.
4. Python for Data Analysis, (2013), Wes Mc Kinney, O'Reilly Media, 2012.

Semester - II

Course Type	Code	Name of Course	L	T	P	Credit
Core		Machine learning & its applications	3	0	0	0

Syllabus



Kimha Tran
24.04.2024

Introduction, Learning Paradigms, Concept Learning, Decision Tree, Bayes Classifier, Bayesian Networks, k-Nearest Neighbor, Support Vector Machines, Kernel Machines, Neural Networks, Perceptron, Multilayered Perceptron, Classifier Evaluation, Ensemble Learning, Boosting, Unsupervised Learning, Clustering, Dimensionality Reduction, Reinforcement Learning, Introduction to Learning Theory.

Text Books/ Reference:

1. Machine Learning - Tom Mitchell (TM)
2. Pattern Classification - Duda, Hart and Stork (DHS)
3. Introduction to Machine Learning - E. Alpaydin (EA)
4. The Elements of Statistical Learning - Hastie, Tibshirani, Friedman (HTF)

Course Type	Code	Name of Course	L	T	P	Credit
Core		<i>Optimization</i>	3	0	0	3

Syllabus

Linear programming - formulation through examples from engineering/business decision making problems, preliminary theory and geometry of linear programs, basic feasible solution, simplex method, variants of simplex method. Duality and its principles, interpretation of dual variables, dual simplex method. Linear integer programming, applications in real decision-making problems, methods to solve linear integer programs, transportation problems: theory and methodology, assignment problems. Zerosum matrix games, saddle point, linear programming formulation of matrix games, network optimization problems LPP formulation. Nonlinear programming, Lagrange function, KKT optimality conditions, sufficiency of KKT under convexity of quadratic programming, Wolfe's method, applications of quadratic programs.

Text Books/ Reference:

1. Vasek Chvatal, Linear programming, W. H. Freeman publishers, 1983.
2. Robert J. Vanderbei, Linear programming: Foundation and Extension, Springer, 2001.
3. S. Chandra, Jayadeva, A. Mehra, Numerical optimization with applications, Narosa, 2009.
4. Hamdy A. Taha, Operations research: An introduction, Pearson Education, 2006.



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Course Type	Code	Name of Course	L	T	P	Credit
Core		Data Structures & Algorithms	3	0	0	3

Syllabus

Review of problem-solving using computers, Abstraction, Elementary Data Types. Algorithm design- Correctness via Loop invariants as a way of arguing correctness of programs, preconditions, post conditions associated with a statement. Complexity and Efficiency via model of computation (notion of time and space), mathematical preliminaries, Elementary asymptotics (big-oh, big-omega, and theta notations).

ADT Array -- searching and sorting on arrays: Linear search, binary search on a sorted array. Bubble sort, Insertion sort, Merge Sort and analysis; Emphasis on the comparison based sorting model. Counting sort, Radix sort, bucket sort.

ADT Linked Lists, Stacks, Queues: List manipulation, insertion, deletion, searching a key, reversal of a list, use of recursion to reverse/search. Doubly linked lists and circular linked lists.

Stacks and queues as dynamic data structures implemented using linked lists. Analyse the ADT operations when implemented using arrays.

ADT Binary Trees: Tree representation, traversal, application of binary trees in Huffman coding. Introduction to expression trees: traversal vs post/pre/infix notation. Recursive traversal and other tree parameters (depth, height, number of nodes etc.)

ADT Dictionary: Binary search trees, balanced binary search trees - AVL Trees. Hashing - collisions, open and closed hashing, properties of good hash functions.

ADT Priority queues: Binary heaps with application to in-place sorting

Sorting: merge, quick, radix, selection and heap sort



Graphs: Representations (Matrix and Adjacency List), basic traversal techniques: Depth First Search + Breadth First Search (Stacks and Queues), directed acyclic graphs and topological sort.

Text Books/ Reference:

1. Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss (Pearson 2007).
2. Data structures and Algorithms in C++ -- by Adam Drozdek (1994 2001).
3. How to solve it by Computer -- by R G Dromey (PHI 1982, Paperback 2008).
4. Fundamental of Data Structures in C – by Horowitz, Sahni and Anderson-Freed (Silicon Press 2007).
5. 5. Data Structure Using C and C++ -- by Y. Langsam, M. J. Augenstein and A. N. Tanenbaum (Pearson Education, 2nd Edition, 2015).

Semester-III						
Course Type	Code	Name of Course	L	T	P	Credit
Core		<i>Deep Learning</i>	3	0	0	3
Syllabus						
<p>Introduction to Deep Learning, Bayesian Learning, Decision Surfaces, Linear Classifiers, Linear Machines with Hinge Loss, Optimization Techniques, Gradient Descent, Batch Optimization, Introduction to Neural Network, Multilayer Perceptron, Back Propagation Learning, Unsupervised Learning with Deep Network, Autoencoders, Convolutional Neural Network, Building blocks of CNN, Transfer Learning, Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam, Effective training in Deep Net- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization, Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, Fully Connected CNN etc., Classical Supervised Tasks with Deep Learning, Image Denoising, Semantic Segmentation, Object Detection etc, LSTM Networks, Generative Modeling with DL, Variational Autoencoder, Generative Adversarial Network Revisiting Gradient Descent, Optimizers.</p>						
Text Books/ Reference:						
1. Deep Learning- Ian Good fellow, Yoshua Benjio, Aaron Courville, The MIT Press						



 Signature: *Arun P. An*

 Date: 24.04.2024

2. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.



Dimant P. Singh
24.04.2024

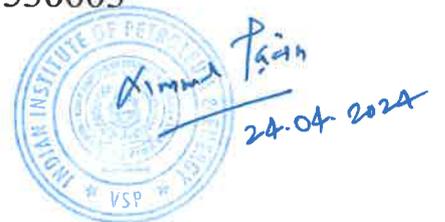
REGISTRAR
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COURSE STRUCTURE and SYLLABUS
for
4 Year B. Tech. in Mathematics & Computing



Indian Institute of Petroleum and Energy

Visakhapatnam, Andhra Pradesh – 530003



Agenda: Proposal to start B. Tech in Mathematics & Computing at IPE, Visakhapatnam.

Overview:

In recent years, there have been several ground-breaking mathematical developments that have far reaching implications on our daily lives. These developments range from mathematical modelling to large scale optimization, solving PDEs via data-driven strategies to mimicking neural processing in human brains, to name but a few. With vast potential for applications, these fundamental topics, not surprisingly, have become cynosure for researchers from several scientific fields while resulting in products like Chat GPT, high precision imaging in medical domain, physics-aware neural processing etc. At the heart of these developments lie some deep rooted advanced mathematical, computational, and data analytic tools, which form the foundational pillars of emerging fields like Artificial Intelligence (AI), Machine Learning (ML), Deep Learning, and Data Science (DS).

Having found the need for trained man power who can grab opportunities by making a foray into these fields, several IITs, NITs and IIITs have of late started offering such programmes as B. Tech/M. Tech/ Integrated M. Sc/ M. Tech with specialization being Mathematics as applied in AI/ML/DS. Intending not to be left behind and being aware of growing importance of these fields, the IPE at Visakhapatnam proposes to introduce a 4-year B. Tech. programme in Mathematics and Computing with emphasis on AI and ML. This visionary program is envisaged to attract the nation's brightest minds through JEE Advanced examination and offer a formidable combination of Mathematics and Computer Science. It is expected that the programme will concentrate on areas where Mathematics and Computing are most relevant and inter-laced. The curriculum has been designed in such a way that this programme provides a perfect platform for those who seek strong Mathematical and Analytical components with specialization in topics like AI/ML/DS/Energy.

To summarize, the program aims to produce future leaders who will be at the forefront of research, development, and innovation in futuristic disciplines and next generation technologies that require deep use of Mathematics, Computer Science and Data Science.

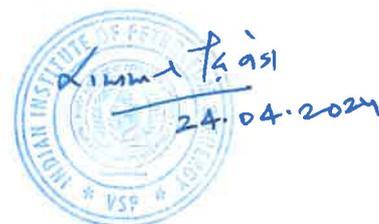
Intake of the students for this programme in upcoming academic year 2024-25 is as follows:

S. No	UG programme	Duration	Total intake
1.	B. Tech. Mathematics & Computing	4 Years	30*

* Reservation policy will be applicable as per the GoI norms.

1. Admission to the Programme:

- a. The admission to B. Tech. Programmes shall be made once in a year normally in July through Joint Entrance Examination (JEE) Advanced Ranking, conducted on an All India Level / Basis by IITs.
- b. The candidates, seeking admission in B. Tech. programmes, shall fulfil the following criteria in addition to the rank in the merit list of Joint Entrance Examination (JEE) Advanced of the respective year. Candidates should have passed intermediate (10+2 (PCM)) with Science Subjects or equivalent examination with minimum 75% marks in aggregate (65% marks in case of students SC/ST/PWD categories).



Degree Requirements:

The degree requirements for undergraduates are specified in terms of

(a) Minimum total credits to be earned. As per the UG manual of IPE, these will be fixed by each department and will generally be between 165 and 180. The summary of credits to be cleared for this programme by each student is as follows.

S. No	Type	No. of credits
1	Institute core	35
2	Departmental core	100
3	Departmental Elective	30
Total		165

(b) These requirements make the programme flexible, as the students can choose courses depending on their varying interests, as long as they satisfy the minimum requirement.

All the rules and regulations of the programme will be followed as per the institute UG programme guidelines.



Kimber T. G. S.
24.04.2024

SEMESTER - I						
Sl. No	Code	Course Name	L	T	P	Credit
1	IC1101	Calculus	3	1	0	4
2	MC1101	Introduction to Programming	3	0	2	4
3		General Chemistry & Lab	3	0	2	4
4		Electrical Technology	2	0	0	2
5		Basic Electronics	2	0	0	2
6		Engineering Graphics	1	0	3	3
7		Engineering Mechanics	3	1	0	4
8		English for Communication	1	0	2	2
9		EAA I	0	0	0	P/F
Total			18	2	9	25

SEMESTER - II						
Sl. No	Code	Course Name	L	T	P	Credit
1	IC1201	Linear Algebra & Differential Equations	3	1	0	4
2	MC1201	Discrete Mathematics	3	0	0	3
3		Physics	3	1	0	4
4		Earth & EE	2	0	0	2
5		Fundamentals of Biological Systems	2	0	0	2
6		Electrical & Electronics Lab	0	0	3	2
7	MC1202	Data Structures & Algorithms	3	0	2	4
8	MC1203	Introduction to Python	1	0	2	2
9		EAA II	0	0	0	P/F
Total			17	2	7	23

SEMESTER - III						
Sl. No	Code	Course Name	L	T	P	Credit
1	MC2101	Abstract Algebra	3	0	0	3
2	MC2102	Real & Complex Analysis	3	1	0	4
3	MC2103	Transform Techniques	2	0	0	2
4	MC2104	Numerical Analysis & Lab	3	0	2	4
5	MC2105	Graph Theory	3	0	0	3
6	MC2106	Object Oriented Programming	3	0	2	4
7	MC2107	Design and Analysis of Algorithms	3	0	0	3
Total			20	1	4	23

SEMESTER - IV						
Sl. No	Code	Course Name	L	T	P	Credit
1	MC2201	Partial Differential Equations	3	0	0	3
2	MC2202	Probability & Statistics	3	1	0	4
3	MC2203	Advanced Linear Algebra & Applications	3	0	0	3
4	MC2204	Optimization Methods and Applications	3	0	0	3
5	MC2205	Theory of Computation	3	0	0	3

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Dimas T. An
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6	MC2206	Operating Systems & Lab	3	0	2	4
7	MC2207	Machine Learning	3	0	0	3
Total			21	1	2	23

SEMESTER - V						
Sl. No	Code	Course Name	L	T	P	Credit
1	MC3101	Statistical Learning: Theory and Applications	3	0	0	3
2	MC3102	Database Management Systems	3	0	2	4
3	MC3103	Pattern recognition	3	0	0	3
4	MC3104	Computer Networks	3	0	0	3
5		Elective-I	3	0	0	3
6		Elective-II	3	0	0	3
Total			18	0	2	19

SEMESTER - VI						
Sl. No	Code	Course Name	L	T	P	Credit
1	MC3201	Deep Learning	3	0	0	3
2	MC3202	Web Technologies	3	0	2	4
2	MC3203	Big Data Analytics	3	0	0	3
4		Elective-I	3	0	0	3
5		Elective-II	3	0	0	3
6		Elective-III	3	0	0	3
Total			18	0	2	19

SEMESTER - VII						
Sl. No	Code	Course Name	L	T	P	Credit
1	MC4101	Project-1	0	0	9	6
2	MC4102	Applied Natural Language Processing	3	0	0	3
3		Elective-I	3	0	0	3
4		Elective-II	3	0	0	3
5		Elective-III	3	0	0	3
Total			12	0	9	18



Timur Kuis
24.04.2024

SEMESTER - VIII						
Sl. No	Code	Course Name	L	T	P	Credit
1	MC4201	Project-2	0	0	9	6
	MC4202	Graph Neural Networks	3	0	0	3
2		Elective I	3	0	0	3
3		Elective II	3	0	0	3
Total			9	0	9	15
CUMULATIVE TOTAL			133	6	44	165

ELECTIVES						
Sl. No	Code	Course Name	L	T	P	Credit
1		Mathematical foundations of AI	3	0	0	3
2		Multivariate Calculus & Measure Theory	3	0	0	3
3		Convex Optimization	3	0	0	3
4		Computational Methods for Differential Equations	3	0	0	3
5		Functional Analysis	3	0	0	3
6		Computational Number Theory	3	0	0	3
7		Stochastic Models	3	0	0	3
8		High-Performance Computing	3	0	3	6
9		Mathematical Modelling and Numerical Simulation	3	0	0	3
10		Financial Mathematics	3	0	0	3
11		Image Processing	3	0	0	3
12		Mathematical Image Processing	3	0	0	3
13		Statistical Simulation & Data Analysis	3	0	0	3
14		Computational Biology	3	0	0	3
15		Applied Functional Analysis	3	0	0	3
16		Compressed Sensing	3	0	0	3
17		Numerical Linear Algebra	3	0	0	3
18		Numerical Methods for Hyperbolic Problems	3	0	0	3
19		Operational Research	3	0	0	3
20		Signals & Systems	3	0	0	3
21		Time Series Analysis	3	0	0	3
22		Numerical Linear Algebra	3	0	0	3
23		Stochastic Processes	3	0	0	3
24		Bioinformatics	3	0	0	3
25		Probability & Computing	3	0	0	3
26		Combinatorial optimization	3	0	0	3

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Amal P. G. S.
24.04.2024

Semester - I

Course Type	Code	Name of Course	L	T	P	Credit
Core	IC1101	Calculus	3	1	0	4

Syllabus

Functions of single variable: Sequences in real numbers, limits and continuity of real-valued functions on intervals, extreme values of functions in interval, Intermediate value property and differentiation, Mean Value Theorems, Indeterminate forms, Taylor's formula, convergence of series, root test, ratio test, Cauchy condensation test, alternating series, Leibnitz's test, absolute and conditional convergence, power series, radius of convergence, Taylor series.

Riemann integration, Riemann integrable functions, Mean value theorems of Integrals, Improper integrals, Beta and Gamma functions and their convergence, comparison test, absolute convergence.

Functions of several variables: Continuity, partial derivatives, directional derivatives and gradient, differentiability, chain rule, tangent plane and normal line, Euler's theorem on homogeneous functions, Taylor's theorem, extreme values, Lagrange multipliers.

Double and triple integrals, volume and area, change of variables, surface area, surface integrals, line integrals, Green's theorem, vector fields, divergence and curl of a vector field, Stoke's theorem, Divergence theorem.

Text Books/ Reference:

1. G. B. Thomas Jr, M. D. Weir, and J. R. Hass, Calculus, Pearson Education (2009).
2. Hughes-Hallett et al., Calculus - Single and Multivariable (3rd Edition), John-Wiley and Sons (2003).
3. James Stewart, Calculus, Thomson (2003).
4. N. Piskunov, Differential and Integral Calculus Vol.1-2, Mir publishers, (1974).
5. Tom M. Apostol, Calculus Vol. 1-2, Wiley, (2007).
6. S.R. Ghorpade, B.V.Limaye, A course in Calculus and Real Analysis, Springer (2017)
7. S.R. Ghorpade, B.V.Limaye, A course in Multivariable Calculus and Analysis, Springer (2017)



Kimbal Tsing
24-04-2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC1102	<i>Introduction to Programming</i>	3	0	2	4

Syllabus

Introduction to Computing: Fundamentals of Computing, Historical perspective, Early computers. Computing machine. Problems, Pseudo-code and flowcharts. Memory, Variables, Values, Instructions, Programs.

Introduction to C:

The language of C : Phases of developing a running computer program in C.

Data concepts in C : Constants, Variables, Expressions, Operators, and operator precedence in C. Statements : Declarations, Input-Output Statements, Compound statements, Selection Statements. Conditions, Logical operators, Precedences. Repetitive statements, while construct, do-while Construct, for construct.

Data types, size and values. Char, Unsigned and Signed data types. Number systems and representations. Constants, Overflow.

Arrays. Strings. Multidimensional arrays and matrices.

Modular Programming:

Functions: The prototype declaration, Function definition.

Function call: Passing arguments to a function, by value, by reference. Scope of variable names. Recursive function calls, Tail recursion. Analysing recursion, Tree of recursion, linear recursion.

Search problem: Linear search and binary search. Comparison between search procedures. Recursive and Iterative formulations.

Sorting problem: Selection Sort, Insertion Sort, Comparison between sorting algorithms. Sorting in multidimensional arrays. Sorting in strings.

More Data Types in C:

Pointers: Pointer variables. Declaring and dereferencing pointer variables. Pointer Arithmetic. Examples. Accessing arrays through pointers. Pointer types, Pointers and strings. String operations in C.

Structures in C : Motivation, examples, declaration, and use. Operations on structures. Passing structures as function arguments. type defining structures.

Self-referential structures. Dynamic Data Structures. Linked Lists. Examples.

File input-output in C. Streams, Input, output and error streams. Opening, closing and reading from files. Programming for command line arguments.

Numerical errors due to data representations and machine precision. Approximation and error analysis. Illustration through examples.

400 003



Timmy T. G. S. J.
24.04.2024

Text Books/ Reference:

1. C: How to program, H. M. Deitel, P. J. Deitel, 7th edition, Pearson Education, 2010.
2. R. G. Dromey, "How to Solve It By Computer", Pearson, 1982
3. A.R. Bradley, "Programming for Engineers", Springer, 2011
4. Kernighan and Ritchie, "The C Programming Language", (2nd ed.) Prentice Hall, 1988
5. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (MIT Press)



Limun Taisy
24.04.2024

Semester - II

Course Type	Code	Name of Course	L	T	P	Credit
Core	IC1201	<i>Linear Algebra & Differential Equations</i>	3	1	0	4

Syllabus

Linear Algebra: Vector spaces, subspaces, linear dependence of vectors, basis and dimensions, linear transformations, matrix representation of a linear transform, rank-nullity theorem. Rank and inverse of a matrix, solution of algebraic equations-consistency conditions, Gaussian elimination and Gauss-Jordan methods, Hermitian, skew Hermitian and unitary matrices, eigenvalues and eigenvectors, Cayley-Hamilton theorem, diagonalizability.

Differential equations:

ODEs: First order differential equations: Exact Equations, integrating factors, Reducible to exact differential equations, linear and Bernoulli's form, Orthogonal trajectories, Lipschitz condition, Picard's theorem (statement only), Examples of non-uniqueness. Homogeneous and non-homogeneous second order ODE's with constant coefficients: Characteristic equation, Linear dependence and Independence, Existence of solutions, Wronskian; method of variation of parameters, general linear differential equations with constant coefficients, Method of undetermined coefficients, Cauchy-Euler equations, System of differential equations with constant coefficients.

PDEs: Linear and non-linear PDEs of first order, Lagrange's equations, Charpit's method. Linear PDEs of second order and their classification. Methods for finding C.F. and P.I. of equations with constant coefficients, Method of separation of variables: solution of one-dimensional wave equation, heat equation and Laplace equation, D'Alembert solution of wave equation.

Text Books/ Reference:

1. K. Hoffman and R. Kunze, Linear Algebra, Pearson publisher
2. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999).
3. S.L. Ross, Differential Equations, Third Edition, Wiley-India (2004).
4. R.C. McOwen, Partial Differential Equations: Methods and Applications, Pearson (2002).
5. G. Strang, Linear Algebra and its Applications.
6. I.P. Stavroulakis, S.A. Tersian, Partial Differential Equations-An Introduction with Mathematica and Maple, World-Scientific, Singapore (1999).



Kimul K. Jay
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC1201	<i>Discrete Mathematics</i>	3	0	0	3

Syllabus

Sets and propositions: Combinations of sets, Finite and Infinite sets, Uncountably infinite sets, Principle of inclusion and exclusion, Mathematical induction. Propositions, Fundamentals of logic, First order logic, Ordered sets.

Permutations, Combinations, Numeric functions, Generating functions.

Recurrence relations and recursive algorithms: Recurrence relations, Linear recurrence relations with constant coefficients, Solution by the method of generating functions, Sorting algorithm.

Relations and functions: Properties of binary relations, Equivalence relations and partitions, Partial and total ordering relations, Transitive closure and Warshal's algorithm.

Boolean algebra : Chains, Lattices and algebraic systems, Principle of duality, Basic properties of algebraic systems, Distributive and complemented lattices, Boolean lattices and algebras, Uniqueness of finite Boolean algebras, Boolean expressions and functions.

Graphs and planar graphs : Basic terminology, Multigraphs and weighted graphs, Paths and circuits, Shortest paths in weighted graphs, Eulerian paths and circuits, Hamiltonian paths and circuits. Colorable graphs, Chromatic numbers, Five-color theorem and Four color problem.

Trees and cut-sets : trees, rooted trees, Path lengths in rooted trees, Spanning trees and BFS & DFS algorithms, Minimum spanning trees and Prims &Kruskal's algorithms.

Text Books/ Reference:

1. C.L.Liu: Elements of Discrete Mathematics, McGraw Hill, 1985.
2. J.P. Tremblay and R Manohar : Discrete Mathematical Structures with applications to Computer Science, McGraw Hill Book Co., New Delhi 1975.
3. J. L. Mott, A. Kandel and T. P. Baker : Discrete Mathematics for Computer Scientists, Reston Pub. Co, 1983.
4. K.D. Joshi: Foundations in Discrete Mathematics, New Age International, 1989.



Arvind Tiagi
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC1202	Data Structures & Algorithms	3	0	2	4

Syllabus

Review of Problem Solving using computers, Abstraction, Elementary Data Types. Algorithm design- Correctness via Loop invariants as a way of arguing correctness of programs, preconditions, post conditions associated with a statement. Complexity and Efficiency via model of computation (notion of time and space), mathematical preliminaries, Elementary asymptotics (big-oh, big-omega, and theta notations).

ADT Array -- searching and sorting on arrays: Linear search, binary search on a sorted array. Bubble sort, Insertion sort, Merge Sort and analysis; Emphasis on the comparison based sorting model. Counting sort, Radix sort, bucket sort.

ADT Linked Lists, Stacks, Queues: List manipulation, insertion, deletion, searching a key, reversal of a list, use of recursion to reverse/search. Doubly linked lists and circular linked lists.

Stacks and queues as dynamic data structures implemented using linked lists. Analyse the ADT operations when implemented using arrays.

ADT Binary Trees: Tree representation, traversal, application of binary trees in Huffman coding. Introduction to expression trees: traversal vs post/pre/infix notation. Recursive traversal and other tree parameters (depth, height, number of nodes etc.)

ADT Dictionary: Binary search trees, balanced binary search trees - AVL Trees. Hashing - collisions, open and closed hashing, properties of good hash functions.

ADT Priority queues: Binary heaps with application to in-place sorting

Sorting: merge, quick, radix, selection and heap sort

Graphs: Representations (Matrix and Adjacency List), basic traversal techniques: Depth First Search + Breadth First Search (Stacks and Queues), directed acyclic graphs and topological sort.

Text Books/ Reference:

1. Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss (Pearson 2007).
2. Data structures and Algorithms in C++ -- by Adam Drozdek (1994 2001).
3. How to solve it by Computer -- by R G Dromey (PHI 1982, Paperback 2008).
4. Fundamental of Data Structures in C – by Horowitz, Sahni and Anderson-Freed (Silicon Press 2007).
5. Data Structure Using C and C++ -- by Y. Langsam, M. J. Augenstein and A. N. Tanenbaum (Pearson Education, 2nd Edition, 2015).



Amal P. S.

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC1202	<i>Introduction to Python</i>	1	0	2	2

Syllabus

Introduction to Python: Install Python and Environment Setup, Python Identifiers, Keywords and Indentation, Getting User Input, Python Data Types, Control Statements, Functions, Modules, Packages, List, Tuples, Dictionaries, and Sets, File I/O, Exception handling, Python Object Oriented, Python Multithreaded Programming, Data Science libraries: Numpy, Pandas, Data Visualization.

Text Books/ Reference:

1. Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 2nd Edition, No starch Press, 2019.
2. Martic C Brown, Python: The Complete Reference, 4th Edition, McGraw Hill Publishers, 2018.
3. Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem Solving Focus, 2nd Edition, Wiley India Edition, 2017.
4. Python for Data Analysis, (2013), Wes Mc Kinney, O'Reilly Media, 2012.



K. Anand

24.04.2024

Semester - III

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2101	<i>Abstract Algebra</i>	3	0	0	3

Syllabus

Group theory: Binary operation, and its properties, Definition of a group, Groups as symmetries, Examples: cyclic, dihedral, symmetric, matrix groups, Subgroups, Cosets, normal subgroups and quotient groups, Conjugacy classes, Lagrange's theorem, The isomorphism theorems, Direct and semi-direct products, Group automorphisms, Symmetric group and alternating group, Actions of groups on sets, Cayley's theorem, orbit and stabilizers, Class equations, p-groups, Sylow's theorem and applications: simplicity of groups, Classification of finite abelian groups.

Ring Theory: Definition and examples, Ring homomorphism, Ideals and Quotient rings, Chinese Remainder Theorem, Integral Domain and quotient fields, Unique factorization domain, Principal Ideal domain, Euclidean domain, Gauss lemma, Polynomial Rings, Irreducibility of Polynomials, Ring of Gaussian Integers.

Text Books/ Reference:

1. J. Gallian: Contemporary Abstract Algebra, Narosa Books Pvt. Ltd.
2. I. N. Herstein: Topics in Algebra, Wiley.
3. D. S. Dummit and R.M. Foote, Abstract Algebra, Wiley.
4. M. Artin, Algebra, PHI.
5. N. Jacobson, Basic Algebra I, Basic Algebra II, Dover Publications.



Amal Kishan
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2102	<i>Real & Complex Analysis</i>	3	1	0	4

Syllabus

Real Analysis: Metric spaces: definition and examples. Open, closed and bounded sets. Interior, closure and boundary. Convergence and completeness. Continuity and uniform continuity. Connectedness, compactness and separability. Heine-Borel theorem. Pointwise and uniform convergence of real-valued functions. Equicontinuity. Ascoli-Arzela theorem.

Complex Analysis: Limits, continuity and differentiability of functions of a complex variable. Analytic functions and the Cauchy-Riemann equations. Definition of contour integrals, Cauchy's integral formula and derivatives of analytic functions. Morera's and Liouville's theorems. Maximum Modulus principle. Taylor and Laurent series. Isolated singular points and residues. Cauchy's Residue theorem and applications.

Text Books/ Reference:

1. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, Paperback Edition, 2017.
2. Walter Rudin, Principles of Mathematical Analysis, McGraw Hill, Third Paperback Edition, 2017.
3. S. Kumaresan, Topology of Metric Spaces, Narosa, Second Edition, 2005.
4. Robert Magnus, Metric Spaces: A Companion to Analysis, Springer Undergraduate Mathematics Series, 2011.



Kimul Kias

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2103	<i>Transform Techniques</i>	2	0	0	2

Syllabus

Laplace Transforms: Definition, linearity property, conditions for existence, shifting properties, Laplace transform of derivatives and integrals, unit step function, Dirac-delta and error function, differentiation and integration of transforms, convolution theorem, inversion, periodic functions, evaluation of integrals by Laplace transforms, solution of initial and boundary value problems.

Fourier Series and Fourier Transforms: Fourier series representation of a function and its convergent properties, half range series, sine and cosine series, Fourier integral representation of a function, Parseval's identity. Fourier transform, Fourier sine and cosine transforms, linearity, scaling, shifting properties, convolution theorem, Applications to initial and boundary value problems.

Text Books/ Reference:

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa publisher
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley publisher.
3. W. Feller, An introduction to Probability theory and its applications
4. Peter V, O'Neil, Advanced Engineering Mathematics, 6th edition.



Amu & P.aisi

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2104	Numerical Analysis & Lab	3	0	2	4

Syllabus

Errors: Floating-point approximation of a number, Loss of significance and error propagation, Stability in numerical computation.

Linear Systems: Gaussian elimination with pivoting strategy, Gauss-Jordon method, LU factorization, Residual corrector method, Solution by iteration: Jacobi and Gauss-Seidel with convergence analysis, Matrix norms and error in approximate solution, Eigenvalue problem: Power method, Gershgorin's theorem, QR factorization and Conjugate-Gradient method.

Nonlinear Equations: Bisection method, Regula-Falsi, Secant method, Newton-Raphson method, Fixed-point iteration method, Rate of convergence, Solution of a system of nonlinear equations.

Interpolation by Polynomials: Lagrange interpolation, Newton interpolation and divided differences, Error of the interpolating polynomials, Piecewise linear and cubic spline interpolation, Trigonometric interpolation, Hermite Interpolation, Data fitting and least-squares approximation problem.

Differentiation and Integration: Difference formulae, Some basic rules of integration, Adaptive quadratures, Gaussian rules, Composite rules, Error formulas.

Ordinary Differential Equations: Taylor's, Euler's and modified Euler's method, Second and Fourth order Runge-Kutta methods.

Text Books/ Reference:

1. K. E. Atkinson, An Introduction to Numerical Analysis, 2nd Edition, Wiley-India, 1989.
2. S. D. Conte and C. de Boor, Elementary Numerical Analysis - An Algorithmic Approach, 3rd Edition, McGraw-Hill, 1981.
3. R. L. Burden and J. D. Faires, Numerical Analysis, 7th Edition, Thomson, 2001.
4. C.F. Gerald, P.O. Wheatley: Applied Numerical Analysis, Addison-Wesley, 1994
5. M K Jain, S R K Iyengar, R K Jain., Numerical Methods for Scientific and Engineering Computation, New Age International.



Amrita Jais

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2105	Graph Theory	3	0	0	3

Syllabus

Introduction to Graphs: Definition and basic concepts; **Trees:** characterizations, counting of minimum spanning tree; **Paths and Distance in Graphs:** Basic Definitions, center and median of a graph, activity digraph and critical path; **Eulerian Graphs:** Definition and Characterization; **Hamiltonian Graphs:** Necessary and sufficient conditions, **Planar Graphs:** properties, dual, genus of a graph; **Graph Coloring:** vertex coloring, chromatic polynomials, edge coloring, planar graph coloring; **Matching and Factorizations:** maximum matching in bipartite graphs, maximum matching in general graphs, Hall's marriage theorem, factorization; **Networks:** The Max-flow min-cut theorem, connectivity and edge connectivity, Menger's theorem; **Graph and Matrices**

Text Books/ Reference:

1. J.A.Bondy and U.S.R.Murty: GraphTheory, Springer,2008.
2. R.Diestel: Graph Theory, Springer(low price edition) 2000.
3. B. Bollob'as, Modern Graph Theory (Graduate Texts in Mathematics 184), 1st ed. Springer-Verlag New York, 1998.



Amrith K. S.

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2106	<i>Object Oriented Programming</i>	3	0	2	4

Syllabus

Introduction

Classes and Objects, Inheritance, Polymorphism, Object Oriented Design

Object Design Implementation in a Programming language (Java/C++/Python)

Interfaces and Packages, Collections, Exceptions, Threads, Event Handling,

Files, Networking, Database Access

Text Books/ Reference:

1. Bertrand Meyer, Object-Oriented Software Construction, Prentice-Hall.
2. Grady Booch, Object Oriented Analysis and Design, Addison-Wesley.
3. Grady Booch, James Rumbaugh and Ivar Jacobson, Unified Modelling Language Guide, Addison-Wesley.
4. Erich Gamma et al., Design Patterns: Elements of Reusable OO Software, Addison-Wesley.
5. Bjarne Stroustrup, The Design and Evolution of C++, Addison-Wesley.
6. Core Java 2, Vol 1, Fundamentals, Cay. S. Horstmann and Gary Cornell, Eighth Edition, Pearson Education.
7. Core Java 2, Vol 2, Advanced Fundamentals, Cay. S. Horstmann and Gary Cornell, Eighth Edition, Pearson Education.
8. Saba Zamir, Handbook of Object Technology, CRC Press.



Kimwani T. Gada

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2107	<i>Design and Analysis of Algorithms</i>	3	0	0	3

Syllabus

Introduction: Problem-solving -- adding 2 n-bit numbers, multiplication as repeated addition. Running time analysis -- recall of asymptotic notation, big-oh, theta, big-omega, and introduce little-oh and little-omega. Worst case and average case complexity.

Basic paradigms with illustrative examples -- incremental design (e.g., incremental sorting, interpolating polynomials), decremental design (e.g., GCD with discussion on input size, factorial), and pruning (e.g., order statistics). Divide and Conquer: Integer multiplication revisited with an efficient algorithm that motivates and leads into recurrences. Solving recurrences using recurrence trees, repeated substitution, statement of master theorem. Brief recall of merge sort and its recurrence. Median in worst case linear time.

Application of Graph Traversal Techniques: Recall representation of graphs, BFS (as a method for SSSP on unweighted graphs), DFS, connected components, topological sorting of DAGs, biconnected components, and strongly connected components in directed graphs.

Greedy Algorithms: Greedy choice, optimal substructure property, minimum spanning trees -- Prim's and Kruskal's, Dijkstra's shortest path using arrays and heaps, fractional knapsack, and Huffman coding (use of priority queue).

Dynamic Programming: Integral knapsack (contrasted with the fractional variant), longest increasing subsequence, edit distance, matrix chain multiplication, and independent sets in trees.

String Matching: Boyer Moore algorithm.

NP-completeness: reduction amongst problems, classes NP, P, NP-complete, and polynomial time reductions

Text Books/ Reference:

1. Introduction to Algorithms, by Cormen, Leiserson, Rivest, and Stein, MIT Press, Third Edition, 2009.
2. Algorithms, by Dasgupta, Papadimitrou and Vazirani, McGraw-Hill Education, 2006.
3. Computer Algorithms, by Horowitz, Sahni, and Rajasekaran, Silicon Press, 2007.
4. Algorithm Design, by Kleinberg and Tardos, Pearson, 2005.
5. Algorithm Design, by Goodrich and Tamassia, Wiley, 2001.



Kimul Paul

24.04.2024

Semester - IV

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2201	<i>Partial Differential Equations</i>	3	0	0	3

Syllabus

Formulation, Linear and quasi-linear first order partial differential equations, Paffian equation, Condition for integrability, Lagrange's method for linear equations. First order non-linear equations, method of Charpit - method of characteristics.

Equations of higher order: Method of solution for the case of constant coefficients, Equations of second order reduction to canonical forms, Characteristic curves and the Cauchy problem, Riemann's method for the solution of linear hyperbolic equations, Monge's method for the solution of non-linear second order equations.

Method of solution by separation of variables. Laplace's equations: Elementary solutions, Boundary value problems, Green's functions for Laplace's equation, Solution using orthogonal functions. Wave equations: One dimensional equation and its solution in trigonometric series, Riemann-Volterra solution, vibrating membrane. Diffusion equations: Elementary solution, Solution in terms of orthogonal functions.

Text Books/ Reference:

1. I.N. Sneddon: Elements of Partial Differential Equations, McGraw Hill, New York, 1957.
2. Ioannis P Stavroulakis, Stepan A Tersian : Partial Differential Equations: An Introduction with MATHEMATICA and MAPLE, World scientific, Singapore, 2004.
3. P. Prasad, Renuka Ravindran: Partial Differential Equations, New Age International, 1985.
4. T. Amaranath: An elementary course in Partial differential equations, Narosa Pub., New Delhi, 2009.



Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2202	<i>Probability & Statistics</i>	3	1	0	4

Syllabus

Probability: The axioms of probability, conditional probability, independence, Bayes' rule, Random variables: Discrete, and continuous random variables, cumulative distribution, probability mass and probability density functions, Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Normal and Gamma distributions.

Functions of random variables, expectation, variance, moments, jointly distributed random variables and joint cumulative probability distribution functions, jointly continuous random variables, independent random variables, covariance, sum of random variables.

Statistics: Sampling distributions: Chi-square, t and F distributions, random sample, sample mean and sample variance, the central limit theorem, distributions of the sample mean and the sample variance for a normal population,

Estimation: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for properties, problems

Testing of Hypotheses: Null and alternative hypotheses, the critical and acceptance regions, two types of errors, power of the test, the most powerful test and Neyman-Pearson fundamental lemma, tests for one sample and two sample problems for normal population (t, F, Z tests), tests for proportions, Chi-square goodness of fit test and its applications, problems.

Text Books/ Reference:

1. Sheldon Ross, A first course in probability, Pearson publisher.
2. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier.
3. J. S. Milton & J. C. Arnold, Introduction to Probability and Statistics, McGraw Hill.
4. W. Feller, An introduction to Probability theory and its applications
5. Alexander Mood, Franklin Graybill D. Boes, Introduction to the theory of Statistics, McGraw Hill



Almud T/S
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2203	<i>Advanced Linear Algebra & Applications</i>	3	0	0	3

Syllabus

Introduce Fields: fields of numbers, finite fields. Review basis and dimension of a vector space, linear transformations, eigenvalue and eigenvector of an operator. LU Factorization. Some applications give rise to Linear Systems Problems Dual and double dual of a vector space and transpose of a linear transformation. Diagonalizability of linear operators of finite dimensional vector spaces, simultaneous triangulation and simultaneous diagonalization. The primary decomposition theorem - diagonal and nilpotent parts. Inner product spaces, Gram-Schmidt orthogonalization, best approximation of a vector by a vector belonging to a given subspace and application to least square problems. Adjoint of an operator, Hermitian, unitary and normal operators. Singular Value Decomposition and its applications. Spectral decomposition. Introduction of bilinear and quadratic forms.

Text Books/ Reference:

1. S. Axler, Linear Algebra Done Right, 2nd edition, Springer-Verlag, 1997.
2. K. Hoffman and R. Kunze, Linear Algebra, Pearson Education India, 2003.
3. G. Strang, Linear Algebra and its Applications.



Alimuddin Khan
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2204	<i>Optimization Methods and Applications</i>	3	0	0	3

Syllabus

Linear programming - formulation through examples from engineering/business decision making problems, preliminary theory and geometry of linear programs, basic feasible solution, simplex method, variants of simplex method. Duality and its principles, interpretation of dual variables, dual simplex method. Linear integer programming, applications in real decision-making problems, methods to solve linear integer programs, transportation problems: theory and methodology, assignment problems. Zerosum matrix games, saddle point, linear programming formulation of matrix games, network optimization problems LPP formulation. Nonlinear programming, Lagrange function, KKT optimality conditions, sufficiency of KKT under convexity of quadratic programming, Wolfe's method, applications of quadratic programs.

Text Books/ Reference:

1. Vasek Chvatal, Linear programming, W. H. Freeman publishers, 1983.
2. Robert J. Vanderbei, Linear programming: Foundation and Extension, Springer, 2001.
3. S. Chandra, Jayadeva, A. Mehra, Numerical optimization with applications, Narosa, 2009.
4. Hamdy A. Taha, Operations research: An introduction, Pearson Education, 2006.



Harsha Jain

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2205	Theory of Computation	3	0	0	3

Syllabus

Finite Automata: Basic Definition of an automaton, Description of a finite automata, Deterministic finite automata (DFA), Non-deterministic finite automata (NFA), transition systems, Acceptability of a string by a finite automata, The equivalence of DFA and NFA, Construction of minimum automaton. Formal Languages: Basic definitions, Chomsky classification of languages, Languages and their relations, Operations on languages, Languages and automata.

Regular Grammars: Identities and regular expressions, Finite automata and regular expressions, Conversion of non-deterministic systems to deterministic systems, Algebraic method using Arden's theorem, Construction of finite automata equivalent to regular expression, Pumping lemma for regular sets, Applications of pumping lemma. Context-free Grammar: Context-free grammars, Parse trees, Ambiguity in context-free grammars, Simplification of context-free grammars, Normal forms of context-free grammars, Pumping lemma, Decision algorithms. Pushdown Automata: Basic definitions, Acceptance by pushdown automata, Pushdown automata, and context-free languages.

Turing Machines and Linear Bounded Automata (LBA): Turing Machines Model, Representation of a Turing machine, Language acceptability by Turing machines, Design of Turing Machines, Universal Turing Machines and other modifications, Model of linear bounded Automaton, Turing machines and type- 0 Grammars, Linear bounded automata and languages, Halting problem of Turing machines, NP-Completeness. Computability: Introduction and basic concepts, Primitive recursive functions, Recursive functions, Partial recursive functions, and Turing machines.

Text Books/ Reference:

1. J. E. Hopcroft, J. Motwani, and J. D. Ull man, Introduction to Automata Theory, Languages and Computation, Pearson Education, Asia, 2002.
2. J. H. Martin, Introduction of Languages and the Theory of Computation, McGraw-Hill International Edition, New York, 1991.
3. Z. V. I. Kohavi, Switching and Finite Automata Theory, Tata McGraw-Hill, New Delhi, 1972.
4. H. R. Lewis and C. H. Papadimitrou, Elements of the Theory of Computation, Pearson Education.



Amrinder Singh
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2206	<i>Operating Systems & Lab</i>	3	0	2	4

Syllabus

Process Management: Scheduling (essential topics: context-switch, unix fork, scheduling algorithms representing fairness, infinite wait, optimal scheduling, priority inversion)

Synchronization Primitives and Problems, Deadlocks (essential topics: Peterson's algorithm, monitors)

Memory Management: Virtual Memory, Demand Paging (essential topics: fragmentation, pinning, Belady's anomaly, thrashing)

File systems; I/O Management (essential topics: DMA, delayed writes, elevator algorithm). Security.

The Lab part shall include experiments that illustrate booting of a system, implementation of process, memory, file and I/O management concepts, preferably using a popular operating system as a case study.

Text Books/ Reference:

1. Operating Systems Concepts, Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Wiley, 2012.
2. The Design of the Unix Operating System: Maurice Bach, Prentice Hall, 1988.
3. References
4. Modern Operating Systems, Andrew S Tanenbaum and Herbert Bos, Fourth Edition, Pearson Education, 2014.
5. Operating Systems: Principles and Practice, Thomas Anderson and Michael Dahlin, Recursive Books, 2014.



D. M. T. G. S.
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC2207	<i>Machine Learning</i>	3	0	0	3

Syllabus

Overview: Machine Learning paradigms; supervised, unsupervised, and reinforcement learning.

Supervised Learning: Bayes classifier, optimality; risk minimization; Generalisation error estimation. Perceptron, logistic regression, least squares, regularization, Kernel methods; SVMs, multilayer Perceptrons, CNNs, and other neural network models. Classifier ensembles, Adaboost algorithm. Unsupervised Learning: Generative models, parameter estimation – Maximum likelihood, Bayesian Methods; latent variables and EM algorithm; graphical models, deep generative models, Principal component Analysis, Independent Component Analysis. Reinforcement Learning and Markov Decision Processes.

Text Books/ Reference:

1. C.M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. S Shalev-Shwartz and S. Ben-David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.
3. Kevin Murphy, Machine learning: A probabilistic perspective, 2012
4. T.Hastie, R.Tibshirani and J.Friedman, The Elements of Statistical Learning: Data Mining, Inference and Prediction', Springer, 2009.
5. A.Zhang, Z.C.Lipton, M.Li, A.J.Smola, Dive into Deep Learning, 2019 (free PDF available)
6. I.Goodfellow, Y.Bengio and A. Courville, Deep Learning, MIT Press, 2016



Kimberly Tan
24.04.2024

Semester - V

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC310	<i>Statistical Learning: Theory and Applications</i>	3	0	0	3

Syllabus

Overview of nearest neighbor, decision theory, roughness penalty regression, Bayesian method; Linear and quadratic discriminant analysis, regularized logistic regression, separating hyperplanes; Basis expansion and regularization: splines, filtering, and feature extraction, bias-variance trade-off; Kernel smoothing methods: kernel density estimation and classification, naive Bayes classifier, radial functions; Model assessment and selection: AIC, BIC, VC dimension, cross-validation, bootstrap; Regression tree, classification tree; Neural network: multi-layer perceptron, feed-forward and recurrent networks, self-organizing map; Support vector machines, data depths; Cluster analysis: K means clustering, independent component analysis; Random forest.

Text Books/ Reference:

1. Hastie T, Tibshirani R and Friedman J, The Elements of Statistical Learning: Data Mining, Inference and Prediction, 2nd Edition, Springer (2013).
2. Webb A R, Statistical Pattern Recognition, 3rd Edition, Wiley (2011).
3. Devroye L, Györfi L and Lugosi G, A Probabilistic Theory of Pattern Recognition, 1st Edition, Springer (1996).
4. Duda R O, Hart P E and Stork D G, Pattern Classification, 2nd Edition, Wiley (2011)
5. Haykin S, Neural Networks: A Comprehensive Foundation, 2nd Edition, Pearson Prentice Hall (1999).
6. Vapnik V N, The Nature of Statistical Learning Theory, 2nd Edition, Springer (2000)



Kimura T.án

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC3102	<i>Database Management Systems</i>	3	0	2	4

Syllabus

Introduction - General introduction to database systems; Database - DBMS distinction, approaches to building a database, data models, database management system, three-schema architecture of a database, challenges in building a DBMS, various components of a DBMS.

E/R Model - Conceptual data modeling - motivation, entities, entity types, various types of attributes, relationships, relationship types, E/R diagram notation, examples. Relational Data Model - Concept of relations, schema-instance distinction, keys, referential integrity and foreign keys, relational algebra operators: selection, projection, cross product, various types of joins, division, example queries, tuple relation calculus, domain relational calculus, converting the database specification in E/R notation to the relational schema.

SQL - Introduction, data definition in SQL, table, key and foreign key definitions, update behaviors. Querying in SQL - basic select-from-where block and its semantics, nested queries - correlated and uncorrelated, notion of aggregation, aggregation functions group by and having clauses, embedded SQL.

Dependencies and Normal forms - Importance of a good schema design, problems encountered with bad schema designs, motivation for normal forms, dependency theory - functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF, join dependencies and definition of 5NF.

Data Storage and Indexes - file organizations, primary, secondary index structures, various index structures - hash-based, dynamic hashing techniques, multi-level indexes, B+ trees.

Transaction processing and Error recovery - concepts of transaction processing, ACID properties, concurrency control, locking based protocols for CC, error recovery and logging, undo, redo, undo-redo logging and recovery methods.

No SQL Database - MongoDB

Text Books/ Reference:

1. Database System Concepts (Sixth Edition) Avi Silberschatz, Henry F. Korth, S. Sudarshan McGraw-Hill 2011 ISBN 978-0071325226/ 0-07-352332-1
2. Database Management Systems, Third Edition Raghu Ramakrishnan and Johannes Gehrke McGraw-Hill ©2003 ISBN: 978-0072465631/ 0-07-246563-8
3. Fundamentals of Database Systems, 7th Edition Ramez Elmasri, University of Texas at Arlington Shamkant B. Navathe Pearson India ©2011 ISBN 978-0321369574
4. Database Systems: The Complete Book, (2nd Edition, 2014) Hector Garcia-Molina, Jeffrey D Ullman and Jennifer Widom Pearson India ISBN: 978-9332518674, 9-33-251867-X



Kimura P. G. S.
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC3103	<i>Pattern Recognition</i>	3	0	0	3

Syllabus

Basics of Probability, Random Processes and Linear Algebra: Probability: independence of events, conditional and joint probability, Bayes' theorem; Random Processes: Stationary and nonstationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra; Linear Algebra: Inner product, outer product, inverses, eigen values, eigen vectors; Bayes Decision Theory

Bayes Decision Theory: Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, discrete features

Parameter Estimation Methods: Maximum-Likelihood estimation: Gaussian case; Maximum a Posteriori estimation; Bayesian estimation: Gaussian case

Unsupervised learning and clustering: Criterion functions for clustering; Algorithms for clustering: K-Means, Hierarchical and other methods; Cluster validation; Gaussian mixture models; Expectation-Maximization method for parameter estimation; Maximum entropy estimation

Sequential Pattern Recognition: Hidden Markov Models (HMMs); Discrete HMMs; Continuous HMMs

Nonparametric techniques for density estimation: Parzen-window method; K-Nearest Neighbour method

Dimensionality reduction: Fisher discriminant analysis; Principal component analysis; Factor Analysis

Linear discriminant functions: Gradient descent procedures; Perceptron; Support vector machines

Non-metric methods for pattern classification: Non-numeric data or nominal data; Decision trees: CART

Text Books/ Reference:

1. R.O. Duda, P.E. Hartand, D.G. Stork, Pattern Classification, John Wiley, 2002.
2. C.M. Bishop, Neural Networks and Pattern Recognition, Oxford University Press (Indian Edition), 2003.
3. Bishop C M, Pattern Recognition and Machine learning, Springer, 2006.
4. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009



Kimani P. asi

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC3104	Computer Networks	3	0	0	3

Syllabus

Introduction to Computer Networking Concepts: Layered Network Protocol Architectures; Personal, Local, Metropolitan and Wide Area Networks; Telecommunications and Cellular Networks overview.

Physical Layer: Basics of communications; Physical media types and their important bandwidth and bit-error-rate characteristics; Wired and Wireless media including copper cables, optical fiber and wireless.

Data Link Layer and Logical Link Control (LLC) sub-layer: Framing; Error control including Bit-parity, CRC and Hamming Codes; Reliable transmission and Automatic Repeat Request (ARQ) protocols including Stop-and-Wait, Go-back-N, Selective Repeat. Performance analysis of ARQ protocols. Example protocols such as HDLC and PPP.

Medium Access Control (MAC) sub-layer: Shared media systems; Bus, Star and Ring topologies; TDMA, FDMA, CSMA, CSMA/CD, Ethernet and IEEE 802.3; IEEE 802.11 including CSMA/CA protocols; Performance analysis; Shared and Switched Ethernet; Related protocols such as ICMP, NAT, ARP and RARP.

Network Layer: Internet Protocol (IP) suite; Hierarchical network architectures; IPv4 and IPv6 addressing and headers; Routing protocols including distance-vector and link-state approaches; Interior and Exterior Gateway Protocol concepts; Routing Algorithms including Dijkstra's algorithm and distributed Bellman-Ford algorithm; Example protocols: OSPF, RIP, BGP.

Transport Layer: Reliable end-to-end transmission protocols; UDP header; Details of TCP header and operation including options headers and congestion control; TCP variants such as Reno, Tahoe, Vegas, Compound and CUBIC.

Application Layer: Socket Interface and Socket programming; Example protocols such as DNS, SMTP, FTP, and HTTP. Advanced topics on some of the recent trends in Computer Networks, depending on time availability. Programming assignments based on the theoretical concepts must be part of the course, with 25% weightage towards course grade.

Text Books/ Reference:

1. Andrew S. Tanenbaum, "Computer Networks", Fifth Edition, Pearson Education India, 2013.
2. Kurose and Ross, "Computer Networking - A top-down approach", Seventh Edition, Pearson, 2017.
3. Peterson and Davie, "Computer Networks, A Systems Approach", 5th ed., Elsevier, 2011 G. Bachman and L. Narici, Functional Analysis, 2nd Ed., Dover Publication, 1998
4. Ying-Dar Liu, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw-Hill, 2011
5. W. Richard Stevens, Bill Fenner and Andrew Rudoff, "Unix Network Programming", Volumes 1 and 2, Third Edition, Addison-Wesley Professional, 2003.
6. Michael Donahoo, Ken Calvert, Pocket Guide to TCP/IP Socket Programming in C, Morgan Kaufmann Series in Networking, 2000.



Kimura Tsun
24.04.2024

Semester - VI

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC3201	Deep Learning	3	0	0	3

Syllabus

Introduction to Deep Learning, Bayesian Learning, Decision Surfaces, Linear Classifiers, Linear Machines with Hinge Loss, Optimization Techniques, Gradient Descent, Batch Optimization, Introduction to Neural Network, Multilayer Perceptron, Back Propagation Learning, Unsupervised Learning with Deep Network, Autoencoders, Convolutional Neural Network, Building blocks of CNN, Transfer Learning, Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam, Effective training in Deep Net- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization, Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, Fully Connected CNN etc., Classical Supervised Tasks with Deep Learning, Image Denoising, Semantic Segmentation, Object Detection etc, LSTM Networks, Generative Modeling with DL, Variational Autoencoder, Generative Adversarial Network Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam.

Text Books/ Reference:

1. Deep Learning- Ian Good fellow, Yoshua Benjio, Aaron Courville, The MIT Press
2. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.



Amma King

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC3202	Web Technologies	3	0	2	4

Syllabus

Introduction to XHTML: Editing XHTML, First XHTML Example, W3C XHTML Validation Service, Headers, Linking, Images, Special Characters and More Line Breaks, Unordered Lists, Nested and Ordered Lists, Internet and World Wide Web Resources;

Dynamic HTML: Object Model and Collections- Introduction, Object Referencing, Collections all and children, Dynamic Styles, Dynamic Positioning, Using the frames Collection, navigator Object, Summary of the DHTML Object Model; Event Model- vent onclick, Event onload, Error Handling with onerror, Tracking the Mouse with Event onmousemove, Rollovers with onmouseover and onmouseout;

Form Processing- Form Processing with onfocus and onblur, More Form Processing with onsubmit and onreset, Event Bubbling, More DHTML Events; Filters and transitions; Data binding with tabular data control, Structured graphics and active X control;

JavaScript: Functions; Program Modules in JavaScript, Programmer Defined Functions, Function Definitions, Random-Number Generation, Duration of Identifiers, Scope Rules, JavaScript Global Functions, Recursion, JavaScript arrays, JavaScript objects;

XML: Structuring Data, XML Namespaces, Document Type Definitions (DTDs) and Schemas, Document Type Definitions, W3C XML Schema Documents, XML Vocabularies, Chemical Markup Language (CML), Other Markup Languages, Document Object Model (DOM), DOM Methods, Simple API for XML (SAX), Extensible Style sheet Language (XSL), Simple Object Access Protocol (SOAP);

Web Servers: HTTP Request Types, System Architecture, Client-Side Scripting versus Server-Side Scripting, Accessing Web Servers, Microsoft Internet Information Services (IIS), Microsoft Personal Web. Server-side Scripting;

Introduction to PHP, String Processing and Regular Expressions, Form processing and Business logic, Dynamic content, Database connectivity, Applets and Servlets, JDBC connectivity, JSP and Web development Frameworks. XML: Introduction to XML, Defining XML tags, their attributes and values, Document type definition, XML Schemas, Document Object model, XHTML, Parsing XML Data - DOM and SAX parsers

Text Books/ Reference:

1. Deitel, Deitel and Nieto, "Internet and Worldwide Web - How to Program", 5th Edition, PHI, 2011.
2. Bai and Ekedhi, "The Web Warrior Guide to Web Programming", 3rd Edition, Thomson, 2008.
3. Web Programming, building internet applications, Chris Bates 2nd edition, Wiley Dremtech
4. Java Server Pages – Hans Bergsten, SPD O'Reilly
5. Java Script, D.Flanagan, O'Reilly, SPD.
6. Beginning Web Programming-Jon Duckett WROX.
7. Programming world wide web, R.W. Sebesta. Fourth Edition, Pearson.
8. Internet and World Wide Web – How to program, Dietel and Nieto, Pearson.



Dimah Tjan
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC3203	<i>Big Data Analytics</i>	3	0	0	3

Syllabus

Introduction to big data: Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting.

Mining data streams: Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis- Stock Market Predictions. Hadoop: History of Hadoop- the Hadoop Distributed File System – Components of Hadoop Analysing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFS Basics- Developing a Map Reduce Application-How Map Reduce Works- Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features Hadoop environment. Frameworks: Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM Info Sphere Big Insights and Streams. Predictive Analytics- Simple linear regression- Multiple linear regression- Interpretation 5 of regression coefficients. Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications.

Text Books/ Reference:

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
2. Tom White “Hadoop: The Definitive Guide” Third Edition, O’reilly Media, 2012.
3. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGrawHill Publishing, 2012.
4. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CUP, 2012.
5. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley & sons, 2012.
6. Glenn J. Myatt, “Making Sense of Data”, John Wiley & Sons, 2007.
7. Pete Warden, “Big Data Glossary”, O’Reilly, 2011.
8. Jiawei Han, Micheline Kamber “Data Mining Concepts and Techniques”, 2 nd Edition, Elsevier, Reprinted 2008.
9. Da Ruan, Guoqing Chen, Etienne E.Kerre, Geert Wets, “Intelligent Data Mining”, Springer, 2007.
10. Paul Zikopoulos, Dirkde Roos, Krishnan Parasuraman, Thomas Deutsch, James Giles , David Corrigan, “Harness the Power of Big Data The IBM Big Data Platform”, Tata McGraw Hill Publications, 2012.
11. Arshdeep Bahga, Vijay Madisetti, “Big Data Science & Analytics: A HandsOn Approach “,VPT, 2016
12. Bart Baesens “Analytics in a Big Data World: The Essential Guide to Data.



Amrita Jain

24.04.2024

Semester - VII

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC4102	<i>Applied Natural language Processing</i>	3	0	0	3

Syllabus

Introduction to language processing – tokens, sentences, paragraphs

Regular expressions - extraction of information using Regex
Document Similarity measures - Cosine and cluster measures
Spelling correction - Edit distance

Information retrieval, extraction
Document Classification, Clustering, topic modeling techniques
Vector Space Model - word vectors, GloVe/Word2Vec model, word embedding

Text Classification, Clustering, and Summarization
Machine Learning, Perceptron
Back Propagation, Recurrent Neural network relevant to NLP
Machine Translation, Language Generation
Applications – Sentiment Analysis, Spam Detection, Resume Mining, AInstein

Text Books/ Reference:

1. Yoav Goldberg Neural Network Methods for Natural Language Processing, Morgan and Claypool (2017).
2. Dan Jurafsky and James Martin Speech and Language Processing, 3rd Edition,



Dimas Prian
24.04.2024

Semester - VIII

Course Type	Code	Name of Course	L	T	P	Credit
Core	MC4202	Graph Neural Networks	3	0	0	3

Syllabus

Representation learning

Graph representation Learning

Graph neural networks

Graph neural networks for node classification

The expressive power of Graph neural networks

Graph neural networks: Scalability

Interpretability in Graph neural networks

Graph neural networks: Adversarial robustness

Graph neural networks: Graph classification

Graph Neural Networks applications: Computer Vision, Natural Language Processing, etc.

Text Books/ Reference:

1. Lingfei Wu, Peng Cui, Jian Pei, Liang Zhao, " Graph Neural Networks: Foundations, Frontiers, and Applications," Springer, 2022.



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24.04.2024

ELECTIVES

Course Type	Code	Name of Course	L	T	P	Credit
Elective		<i>Financial Mathematics</i>	3	0	0	3

Syllabus

Financial markets, Interest computation, value, growth and discount factors, derivative products, basic option theory: single and multiperiod binomial pricing models, Cox-Ross-Rubinstein (CRR) model, volatility, Black-Scholes formula for option pricing as a limit of CRR model, Greeks and hedging, Mean-Variance portfolio theory: Markowitz model, Capital Asset Pricing Model (CAPM), factor models, interest rates and interest rate derivatives, Binomial tree models.

Text Books/ Reference:

2. Capinski M. and Zastawniak T., "Mathematics for Finance- An introduction to financial engineering", Springer
3. Teall J. L. and Hasan I., "Quantitative methods for finance and investments", Blackwell Publishing
4. Hull J.C., "Options, futures and other derivatives", Pearson education
5. Chandra P., "Financial Management – Theory and Practice", Tata Mcgraw Hill
6. Wilmott P., Howison S. and Dewynne J., "The mathematics of financial derivatives- A student introduction", Cambridge University Press.



Amud Jain
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Elective		<i>Stochastic Models</i>	3	0	0	3

Syllabus

Definition and classification of general stochastic processes. Markov Chains: definition, transition probability matrices, classification of states, limiting properties. Markov Chains with Discrete State Space: Poisson process, birth and death processes. Renewal Process: renewal equation, mean renewal time, stopping time. Applications to queuing models. Markov Process with Continuous State Space: Introduction to Brownian motion.

Text Books/ Reference:

1. R. Aris, Mathematical Modelling Techniques, Dover, 1994.
2. C. L. Dym and E. S. Ivey, Principles of Mathematical Modelling, Academic Press, 1980.
3. M. S. Klamkin, Mathematical Modelling: Classroom Notes in Applied Mathematics, SIAM, 1986.
4. A. Friedman and W. Littman, Industrial Mathematics for Undergraduates, SIAM, 1994.
5. Bhat, U. N. and Miller, G.K., Elements of Applied Stochastic Processes, 3rd edition, John Wiley & Sons, New York, 2002.
6. Kulkarni, V.G., Modeling and Analysis of Stochastic Systems, 3rd Edition, Chapman and Hall/CRC, Boca Raton, 2017.
7. J. Medhi, Stochastic Models in Queuing Theory, Academic Press, 1991.
8. R. Nelson, Probability, Stochastic Processes, and Queuing Theory: The Mathematics of Computer Performance Modelling, Springer Verlag, New York, 1995
9. Sheldon M Ross: Stochastic Processes, John Wiley and Sons, 1996.
10. S Karlin and H M Taylor: A First Course in Stochastic Processes, Academic Press, 1975.



Course Type	Code	Name of Course	L	T	P	Credit
Elective		<i>Computational Methods for Differential Equations</i>	3	0	0	3

Syllabus

Ordinary Differential Equations: Initial Value Problems (IVP) and existence theorem. Truncation error, deriving finite difference equations. Single step methods for I order IVP- Taylor series method, Euler method, Picard's method of successive approximation, Runge Kutta Methods. Stability of single-step methods.

Multi-step methods for I order IVP - Predictor-Corrector method, Euler PC method, Milne and Adams Moulton PC method. System of first order ODE, higher order IVPs. Stability of multistep methods, root condition. Linear Boundary Value Problems (BVP), finite difference methods, shooting methods, stability, error and convergence analysis. Non-linear BVP, higher order BVP.

Partial Differential Equations: Classification of PDEs, Finite difference approximations to partial derivatives. Solution of one-dimensional heat conduction equation by Explicit and Implicit schemes (Schmidt and Crank Nicolson methods), stability and convergence criteria.

Laplace equation using standard five-point formula and diagonal five-point formula, Iterative methods for solving the linear systems. Hyperbolic equation, explicit/implicit schemes, method of characteristics. Solution of the wave equation. Solution of I order Hyperbolic equation. Von Neumann stability.

Text Books/ Reference:

1. ELEMENTARY NUMERICAL ANALYSIS An Algorithmic Approach (Mc-GrawHill) S. D. Conte, Carl de Boor
2. Numerical Solution of Partial Differential Equations: Finite Difference Methods (Oxford Applied Mathematics & Computing Science Series), G. D. Smith
3. Numerical Solution of Ordinary Differential Equations(Wiley), Kendall E. Atkinson, Weimin Han, David E. Stewart
4. Numerical Methods for Scientific and Engineering Computation (New Age International) M K Jain, S R K Iyengar, R K Jain.



Amrinder Kaur
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Elective		<i>Functional Analysis</i>	3	0	0	3

Syllabus

Normed linear spaces, Banach spaces, Equivalence of norms on finite-dimensional spaces, Riesz lemma and characterization of finite dimensional normed spaces, Hamel basis and Schauder basis of normed spaces, Separable normed spaces.

Bounded linear operators, Continuous linear functionals, Hahn-Banach theorems (separation and extension theorems), Dual and bidual of a normed linear space, Dual of some classical spaces like c_0 , l_p , L_p (for $p \geq 1$) and $C(K)$; Reflexive spaces, weak convergence.

Uniform boundedness principle, Open mapping theorem, Closed graph theorem.

Transpose of an operator, Compact operators, Spectra of bounded linear operators and compact operators.

Hilbert spaces, Bessel's inequality, Orthonormal basis, Separable Hilbert space, Orthogonal projection, Riesz Representation Theorem.

Operators on Hilbert spaces: Adjoint of an operator, Normal, unitary, self-adjoint operators, positive operators and their spectra, Spectral theorem for compact self-adjoint operators.

Text Books/ Reference:

1. J. B. Conway, A course in functional analysis, GTM (96), Springer, 2007
2. B. V. Limaye, Functional Analysis, 3rd Ed., New Age International Publishers, 2014
3. M. Reed and B. Simon, Methods of Modern Mathematical Physics, Vol. 1: Functional Analysis, Academic Press, 1980
4. G. Bachman and L. Narici, Functional Analysis, 2nd Ed., Dover Publication, 1998
5. S. Kesavan, Functional Analysis, TRIM series, Hindustan Book Agency, 2009
6. Yosida, K., Functional Analysis, 6th Ed., Springer-Verlag Berlin Heidelberg, 1995
7. Rajendra Bhatia, Notes on Functional Analysis, Hindustan Book Agency, 2015
8. M. T. Nair, Functional analysis: A first course, PHI-Learning, New Delhi, Fourth Print, 2014



Anna Univ
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Elective		<i>Multivariate Calculus and Measure Theory</i>	3	0	0	3

Syllabus

Functions of several variables, open sets in Euclidean spaces, limits, continuity, differentiation of functions of several variables; Inverse function theorem; Implicit function theorem; Review of Riemann-Stieltjes integral; Lebesgue measure, Lebesgue outer measure, Lebesgue measurable sets, measure on an arbitrary sigma-algebra; Measurable functions, integral of a simple measurable function, integral of positive measurable functions; Lebesgue's monotone convergence theorem; Lebesgue integrability; Dominated convergence theorem; L_p -spaces; Differentiation and fundamental theorem for Lebesgue integration; Product measure; Statement of Fubini's theorem.

Text Books/ Reference:

1. Royden H L, Real Analysis, Prentice Hall of India (1995).
2. Rudin W, Real and Complex Analysis, McGraw-Hill, International Editions (1987).
3. Barra G D, Measure and Integration, Wiley Eastern Ltd (1981).
4. Edwards H M, Advanced Calculus: A Differential Forms Approach, Birkhauser (1994).
5. Folland G B, Advanced Calculus, Pearson (2012).
6. Rana I K, An Introduction to Measure and Integration, Narosa Publishing Agencies (1997).



Timma Jais
24/04/2024

Course Type	Code	Name of Course	L	T	P	Credit
Elective		<i>Computational Number Theory</i>	3	0	0	3

Syllabus

Arithmetic of Integers, multi-precision arithmetic, divisibility, gcd, modular arithmetic, linear congruences, Chinese remainder theorem, polynomial congruences and Hensel lifting, orders and primitive roots, quadratic residues.

Representation of finite fields, Prime and extension fields, representation of extension fields, polynomial basis, primitive elements, normal basis, optimal normal basis, irreducible polynomials.

Algorithms for polynomials, root-finding and factorization, polynomials over finite fields, Lenstra-Lenstra-Lovasz algorithm.

Elliptic curves, The elliptic curve group, elliptic curves over finite fields, Schoof's point counting algorithm.

Primality testing algorithms, Fermat test, Miller-Rabin test, Solovay-Strassen test, AKS test.

Integer factoring algorithms, Trial division, Pollard rho method, p-1 method, CFRAC method, quadratic sieve method, elliptic curve method.

§Computing discrete logarithms over finite fields -- Baby-step-giant-step method, Pollard rho method, Pohlig-Hellman method, index calculus methods, linear sieve method, Coppersmith's algorithm.

Applications -- Algebraic coding theory, cryptography.

Text Books/ Reference:

1. A. Das, *Computational Number Theory*, CRC Press. [Main Text]
2. V. Shoup, *A computational introduction to number theory and algebra*, Cambridge University Press.
3. H. Cohen, *A course in computational algebraic number theory*, Springer-Verlag.
4. J. von zur Gathen and J. Gerhard, *Modern computer algebra*, Cambridge University Press.
5. J. H. Silverman and J. Tate, *Rational points on elliptic curves*, Springer International Edition.
6. I. Niven, H. S. Zuckerman and H. L. Montgomery, *An Introduction to the Theory of Numbers*, John Wiley and Sons.
7. G. H. Hardy and E. M. Wright, *An Introduction to the Theory of Numbers*, Oxford University Press.
8. J. von zur Gathen and J. Gerhard, *Modern computer algebra*, Cambridge University Press.



Arun K Das

24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
<i>Elective</i>		<i>Convex Optimization</i>	3	0	0	3

Syllabus

Convex analysis: convex sets, convex cones, polyhedral sets, extreme points and directions. Convex functions, properties and tests for convexity, operations that preserve convexity, conjugate function.

Convex optimization problems: standard form, equality and inequality constraints, slack variables, eliminating equality and inequality constraints. Local and global optima. Optimality criterion for unconstrained, equality constrained and inequality constrained problems.

Linear optimization problems with examples, linear and generalized linear-fractional programming. Quadratic problems with examples. Second order cone programming – robust linear programming, linear programming with random constraints. Geometric programming with examples. Generalized inequality constraints – conics form problems, semidefinite programming, examples.

Handling non-convexity: Lagrangian duality theory – Lagrangian dual function, strong and weak duality, duality gap. Certificate of suboptimality and stopping criteria, complementary slackness. KKT optimality conditions. Solving the primal via dual.

Text Books/ Reference:

1. S. Boyd and L. Vandenberghe, Convex optimization, Cambridge University Press, 2008.
2. M.S. Bazaraa, H.D. Sherali and C.M. Shetty, Nonlinear Programming, 3/e, Wiley, 2006.
3. D. P. Bertsekas, Nonlinear programming, Athena Scientific, 1999.
4. D. G. Luenberger and Y. Ye, Linear and nonlinear programming, 3/e, Springer, 2008.



Kimul Jain
24. 04. 2024

Course Type	Code	Name of Course	L	T	P	Credit
Elective		High-Performance Computing	3	0	3	6

Syllabus

Parallel Processing Concepts; Levels and model of parallelism: instruction, transaction, task, thread, memory, function, data flow models, demand-driven computation; Parallel architectures: superscalar architectures, multi-core, multi-threaded, server and cloud; Fundamental design issues in HPC: Load balancing, scheduling, synchronization and resource management; Operating systems for scalable HPC; Parallel languages and programming environments; OpenMP, Pthread, MPI, java, Cilk; Performance analysis of parallel algorithms; Fundamental limitations in HPC: bandwidth, latency and latency hiding techniques; Benchmarking HPC: scientific, engineering, commercial applications and workloads; Scalable storage systems: RAID, SSD cache, SAS, SAN; HPC based on cluster, cloud, and grid computing: economic model, infrastructure, platform, computation as service; Accelerated HPC: architecture, programming and typical accelerated system with GPU, FPGA, Xeon Phi, Cell BE; Power-aware HPC Design: computing and communication, processing, memory design, interconnect design, power management; Advanced topics: peta scale computing; big data processing, optics in HPC, quantum computers.

HPC programming assignments: Hands on experiment and programming on parallel machine and HPC cluster using Pthread, OpenMP, MPI, Nvidia Cuda and Cilk. Also there will be some hands on experiments on standard multiprocessor simulator or cloud simulator.

Text Books/ Reference:

1. Georg Hager and Gerhard Wellein. Introduction to High Performance Computing for Scientists and Engineers (1st ed.). CRC Press, Chapman & Hall/CRC Computational Science, India, 2010.
2. Vipin Kumar , Ananth Grama , Anshul Gupta , George Karypis. Introduction to Parallel Computing (2nd ed.). Pearson India . 2003.
3. John L. Hennessy and David A. Patterson. Computer Architecture: A Quantitative Approach (5th ed.). Elsevier India Pvt. Ltd. 2011.
4. David B. Kirk and Wen-mei W. Hwu. Programming Massively Parallel Processors: A Hands-On Approach (1st ed.). Elsevier India Pvt. Ltd. 2010.
5. Michael T. Heath. Scientific Computing: An Introductory Survey (2nd ed.). McGraw Hill Education (India) Private Limited, 2011



Kim - Pias
24.04.2024

Course Type	Code	Name of Course	L	T	P	Credit
Elective		Mathematical Modeling and Numerical Simulation	3	0	0	3

Syllabus

Model and its different types, Finite models, Statistical models, Stochastic models, Formulation of a model, Laws and conservation principles, Discrete and continuous models, Manipulation into its most respective form, Evaluation of a model. Case studies, Continuum model, Transport phenomena, Diffusion and air pollution models, Microwave heating, Communication and Information technology.

Software Support: MATHEMATICA, LSODE, GNU PLOT, MATLAB.

Text Books/ Reference:

1. R. Aris, Mathematical Modelling Techniques, Dover, 1994.
2. C. L. Dym and E. S. Ivey, Principles of Mathematical Modelling, Academic Press, 1980.
3. M. S. Klamkin, Mathematical Modelling: Classroom Notes in Applied Mathematics, SIAM, 1986.
4. A. Friedman and W. Littman, Industrial Mathematics for Undergraduates, SIAM, 1994.



Kimha T. Gan

24.04.2024

REGISTRAR

INDIAN INSTITUTE OF PETROLEUM & ENERGY
VISAKHAPATNAM

**Indian Institute of Petroleum & Energy (IPE) Visakhapatnam,
Andhra Pradesh**

Department of Mechanical Engineering

Course Type	Course Code	Name of Course	L	T	P	Credit
Institute Elective		Desalination Engineering: Technology and Design Aspects	2	2	0	4

Name of the Faculty : Dr. H. SHARON	Scheme of Evaluation
Designation : Assistant Professor	Assignment + Attendance : 20 Marks
Year / Semester : IV/ VIII	Mid Semester Examination : 30 Marks
UG/PG/PhD : U.G	End Semester Examination : 50 Marks
Branch : All Engineering	Total : 100 Marks

Course Objective
<p>Upon successful completion of the course the candidate will be able to</p> <p>CO1 – Identify water scarce zones in the globe and identify different available desalination technologies</p> <p>CO2 – Perform basic calculations for sizing Multi Stage Flash (MSF), Multi Effect Distillation (MED), Reverse Osmosis (RO), Electrodialysis (ED), Forward Osmosis (FO), and Membrane Distillation (MD) systems</p> <p>CO3 – Configure hybrid desalination systems for better performance and water recovery</p>
Learning Outcomes
<p>LO1 – Importance of water, necessity of water conservation, water scarcity issues and technologies to address them</p> <p>LO2 – Thermodynamic modelling and sizing of various Multi Stage Flash (MSF), Multi Effect Distillation (MED) configurations</p> <p>LO3 – Importance of vapour compression systems in thermal desalination systems</p> <p>LO4 – Concept of pressure and electric potential gradient desalination, sizing of Reverse Osmosis (RO) and Electrodialysis (ED) system</p> <p>LO5 – Concept of temperature, concentration gradient driven membrane desalination, sizing of Forward Osmosis (FO), Membrane Distillation (MD) and Hybrid desalination systems</p>
Pre-Requisite: Thermodynamics, Heat and Mass transfer, Fluid Mechanics

Unit No	Topics to be Covered	Lecture + Tutorial Hours	Learning Outcome	Course Content at Par with
I	Introduction to Desalination Technologies Water distribution; Water scarcity; Water stress; Need for desalination; Water properties; Drinking water standards; Overview of desalination technologies; Status of global desalination technologies and market; Concept of renewable energy integration with desalination	(5)	LO1	Massachusetts Institute of Technology, USA
II	Multi-Effect Distillation (MED) and Multi-Stage Flash (MSF) Thermal Desalination Technology Concept of vaporization; MED process; MED system configuration; MED Mathematical model for MED various configurations; Concept of flashing; MSF system configurations and modeling; Energy and exergy analysis	(12)	LO2	Technical University of Munich, Germany; King Saud University, Saudi Arabia
III	Vapor Compression Integrated Desalination Technologies Need for vapor compression system in MSF and MED systems; Types of vapor compression process/systems; Mathematical modeling; Energy and Exergy analysis	(8)	LO3	King Saud University, Saudi Arabia
IV	Membrane Desalination: Reverse Osmosis (RO) and Electrodialysis (ED) Semi-permeable membrane properties, Nano filtration (NF), Ultra filtration (UF), Microfiltration (MF) and RO concept; various performance related parameters; RO system components; RO mathematical model; RO-Energy recovery device; ED concept; ED mathematical model; ED performance	(10)	LO4	Technical University of Munich, Germany; King Saud University, Saudi Arabia



V	Membrane Desalination: Membrane Distillation (MD) and Forward Osmosis (FO) MD concept; types; heat and mass transfer aspects; MD mass transfer modeling; Fouling and Scaling in MD membranes; FO concept; FO configuration; FO concentration polarization; Hybrid membrane desalination systems	(10)	LO5	Technical University of Munich, Germany
	Total Hours	45		

Text Books:

- a. Fuad Nesf Alasfour (2020). Introduction to Desalination: Systems, Processes and Environmental Impacts. Wiley-VCH.

Reference Books:

- a. Hisham T. El-Dessouky and Hisham M. Ettouney (2002). Fundamentals of Salt Water Desalination. Elsevier Science.
- b. Jane Kucera (2019). Desalination – Water from Water. Wiley-Scrivener.
- c. Vassilis Belessiotis, Soteris Kalogirou and Emmy Delyannis (2016). Thermal Solar Desalination: Methods and Systems. Academic Press.
- d. H. Sharon, K. Srinivas Reddy (2024). Solar Thermal Desalination Technologies for Potable Water (Exploring Viable Options for Reliable and Sustainable Water Production). Springer Cham.



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Andhra Pradesh**

Department of Mechanical Engineering

Course Type	Course Code	Name of Course	L	T	P	Credit
Institute Elective		SOLAR ENERGY UTILIZATION	3	0	0	3

Name of the Faculty : Dr. H. SHARON	Scheme of Evaluation
Designation : Assistant Professor	Assignment + Attendance : 20 Marks
Year / Semester : IV / VII	Mid Semester Examination : 30 Marks
UG/PG/PhD : U.G	End Semester Examination : 50 Marks
Branch : All Engineering	Total : 100 Marks

Course Objective

Upon successful completion of the course the candidate will be able to

- CO1: Estimate solar energy potential of any location
- CO2: Size PV system for various applications
- CO3: Size solar thermal system for various heating and cooling demands
- CO4: Assess feasibility of solar energy systems

Learning Outcomes

- LO1: Ability to assess solar radiation potential in any location
- LO2: Ability to extract various parameters from PV data sheet
- LO3: Ability to design on-grid and off-grid PV systems based on electric loads
- LO4: Ability to assess performance of various solar thermal collectors
- LO5: Ability to utilize solar thermal systems for various applications and asses of economics of solar energy systems



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Unit No	Topics to be Covered	Lecture + Tutorial Hours	Learning Outcome	Course Content at Par with
I	<p>Solar Radiation Modeling and Measurement</p> <p>Necessity of renewable energy utilization; Structure of the sun; Sun-earth geometric relationship; Concept of various seasons and estimation of different solar angles; Solar Chart and optimum tilt angle; Concept of solar constant Extraterrestrial solar radiation estimation; Terrestrial solar radiation estimation over horizontal and tilted surfaces; Estimation of solar time and local standard time, air-mass ratio, peak sunshine hours, sunshine duration; Solar radiation measuring instruments</p>	(8)	LO1	IIT Kharagpur IIT Guwahati
II	<p>Solar Photovoltaic Cell – Characteristics</p> <p>Basics of insulator, conductor and semi-conductor; Working of solar PV cell and concept of diode; PV cell equivalent circuit and I-V curve; Estimation of photocurrent, diode current, load current; PV cell parameters: short circuit current, open circuit voltage, shunt resistance, series resistance, Maximum power point, fill factor, efficiency of PV cell, module; PV data sheet information; Impact of shunt resistance, series resistance, leakage current, radiation, temperature, ideality factor on I-V characteristics; Concept of load line, cells in series, cells in parallel – I-V curves; Effect of cell shading, hot spots, by-pass diodes</p>	(8)	LO2	IISc Bangalore
III	<p>Solar Photovoltaic System Sizing</p> <p>Concept of module interconnection; Concept and different methods of MPPT; Estimation of electrical loads; Solar PV module sizing methodology; Batteries – parameters, sizing and selection; Off-grid PV module and battery sizing; Grid connected PV system design rules; Balance of systems (Solar PV mechanical and electrical components)</p>	(8)	LO3	IISc Bangalore



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IV	Solar Thermal Collectors Need for solar thermal systems; Overview of Flat Plate Collectors; Energy Balance in Flat-Plate Collectors; Flat Plate Collector Performance and Characterization; Non-Imaging Concentrators; Imaging Concentrators; Heat Transfer fluids; Performance of solar thermal collectors	(12)	LO4	The Pennsylvania State University, USA
V	Solar Thermal System Application and Economics Buildings and district heating; cooling; power plants; drying; desalination; Market for solar systems; payback period; life cycle costing; economics of various solar systems	(10)	LO5	The Pennsylvania State University, USA
Total Hours		46		

Text Book:

1. Foster, R, Ghassemi, M, Cota, A, 2010. Solar Energy. CRC Press
2. Garg, H.P, Prakash, J, 2017. Solar Energy: Fundamentals and Application. Tata McGraw-Hill
3. Sukhatme, P. S., Nayak, J.K., 2009. Solar Energy: Principles of Thermal Collection and Storage. McGraw-Hill Education (India)

Reference Books:

1. Hans S. Rauschenbach, 2013. Solar Cell Array Design Handbook: The Principles and Technology of Photovoltaic Energy Conversion. Springer.
2. Hu C, White, M. 1983. Solar Cells: From Basic to Advanced Systems. McGraw Hill
3. Soteris A. Kalogirou, 2009. Solar Energy Engineering: Processes and Systems. Academic Press.



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Department of Mechanical Engineering

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		Fluid machines	3	1	0	4

Name of the Faculty	Dr. Arun Kumar Pujari	Scheme of Evaluation	
Designation	Associate Professor	Assignment+Attendance	20 Marks
Year/Semester	I/I	Mid Semester Examination	30 Marks
UG/PG/Ph.D.	PG/Ph.D.	End Semester Examination	50 Marks
Branch	All Engineering	Total	100 Marks

Course Objective

1. To understand kinematic and dynamic behavior of fluid while passing through different fluid machines.
2. To understand working and performance characteristics of various hydraulic machines.
3. To provide knowledge about in field application and operational aspects of various hydraulic machines.

Learning Outcomes

Upon successful completion of this course, students will:

1. have a broad understanding of classification of fluid machines used to handle different fluid for different purpose.
2. have an understanding of basics of roto-dynamic machines
3. be able to design different types of fluid machines based on dimensional analysis.
4. be able to understand operation principle of different fluid machines, design or select it for particular
5. purpose and identify the reasons for faults during operation.

Unit No	Topics	Learning Outcome	Content compared with Which University
1.	Introduction: incompressible and compressible flow. Classification and field of application of fluid machines, Jet Striking Plates.	<ul style="list-style-type: none"> • Understanding basics of fluid flow. Classification of fluid machines and types of fluid handled by the machines. 	IIT Madras IIT Kharagpur IIT Guwahati

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Arun Pujari

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Department of Mechanical Engineering

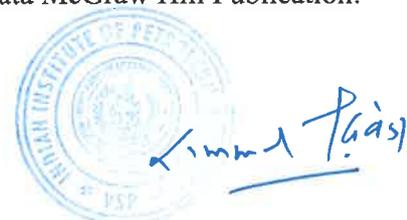
2.	Water Turbines: Theory of Rotodynamic Machines- Euler's Equation, components of energy transfer, Classification – Impulse and Reaction Turbines, Construction, Operation, Head and efficiencies, Power calculation and governing of Pelton, Francis and Kaplan turbines; Draft tube; Surge tank.	<ul style="list-style-type: none">Basics of roto-dynamic machines. Detailed introduction and operation of different hydraulic turbines.	IIT Madras IIT Kharagpur IIT Guwahati
3.	Dimensional analysis: Application of dimensional analysis in fluid machines - Unit quantities and Specific speed	<ul style="list-style-type: none">Utility of dimensional analysis to design and analyze the performance of fluid machines.	IIT Madras IIT Kharagpur IIT Guwahati
4.	Centrifugal Pumps: Types; Heads and efficiencies; Construction of impeller and casing; Multi-stage pumps; Specific speed; Model testing; Characteristic curves; NPSH; Cavitation; Selection of centrifugal pump.	<ul style="list-style-type: none">This unit demonstrates the operation principle of centrifugal pump handling water.	IIT Madras IIT Kharagpur IIT Guwahati
5	Reciprocating Pumps: Classification with constructional details; Theory; Indicator diagram; Effect of acceleration of piston; Effect of friction in pipes; Air vessel and its effects; NPSH. Rotary Positive Displacement Pumps: Types and constructional details.	<ul style="list-style-type: none">This unit demonstrates the operation principle of reciprocating pump handling liquid.	IIT Madras IIT Kharagpur IIT Guwahati

Text Book:

1. Introduction to Fluid Mechanics, S.K. Som, Gautam Biswas and Suman Chakraborty, 3rd Edition, 2011, McGraw Hill Publication.

Reference books:

1. Fluid Mechanics, Victor L Streeter, E. Benjamin Wylie and K.W. Bedford, 9th Edition, McGraw Hill Publication.
2. Mechanics of Fluids, I.H. Shames, 3rd edition, 2013, Tata McGraw Hill Publication.



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Department of Mechanical Engineering

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		Mechanical Measurement	3	1	0	4

Name of the Faculty	Dr. Arun Kumar Pujari	Scheme of Evaluation	
Designation	Associate Professor	Assignment+Attendance	20 Marks
Year/Semester	I/II	Mid Semester Examination	30 Marks
UG/PG/Ph.D.	PG/Ph.D.	End Semester Examination	50 Marks
Branch	All Engineering	Total	100 Marks

Course Objective

4. To provide knowledge of various measuring instruments, highly accurate and precise instruments.

Learning Outcomes

Upon successful completion of this course, students will:

6. Learn use of measuring instruments, errors and sources of errors.

Unit No	Topics	Learning Outcome	Content compared with Which University
1.	Introduction to measurement, definition, purpose and structure of measurement systems, linear and angular measurements, Errors in measuring instruments, sources of errors, types of errors and quantification of different types of errors in measurement; principle of calibration.	<ul style="list-style-type: none"> Introduction to measuring systems. 	IIT Madras IIT Roorkee
2.	Static and dynamic performance characteristics of measuring instruments, Limits, fits and tolerances; comparators. Interferometry, form and surface finish measurement.	<ul style="list-style-type: none"> Behavior of measuring instruments under different measuring conditions. 	IIT Madras IIT Roorkee
3.	Surface temperature measurements using various methods	<ul style="list-style-type: none"> Able to perform surface temperature measurement 	IIT Madras IIT Roorkee

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4.	Principle of measurement of pressure, mass flow rate, strain, force, heat transfer coefficient, heat flux, velocity measurement, torque, and other mechanical parameters.	• Knowledge about measurements of different mechanical parameters.	IIT Madras IIT Roorkee
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Text Book:

Reference:

1. Experimental Methods for Engineers, J. P Hollman, Tata McGraw-Hill Education, 8E,2011.

Reference books:

1. Bentley John, P. Principle of Measurement system, Pearson education, 2005.
2. Measurement and Instrumentation in Engineering: Principles and Basic Laboratory Experiments, Francis L. S. Tse, Ivan E. Morse, Marcel Dekker Inc, New York.
3. Mechanical Measurement, Beckwith Thomas G, Narosa Publishing House.
4. Measurement systems, Application design, E.O. Doeblein, McGraw Hill.
5. Instrumentation, Measurement and Analysis (2/e), Nakra & Chowdhury.

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		Advanced Concepts in Fluid Mechanics and Multiphase flow	3	1	0	4

Name of the Faculty	Dr. Santosh Kumar Senapati	Scheme of Evaluation	
Designation	Assistant Professor	Assignment+Attendance	20 Marks
Year/Semester	I/I	Mid Semester Examination	30 Marks
UG/PG/Ph.D.	PG/Ph.D.	End Semester Examination	50 Marks
Branch	All Engineering	Total	100 Marks

Course Objective

- To understand, apply and analyze the dynamics of viscous fluid flow and governing equations dictating various types of flow problems.
- To understand, apply and analyze the concept of boundary layer theory and flow separation.
- To understand, apply and analyze the turbulent flow and its modeling.
- To understand, apply and analyze the hydrodynamics of Multiphase flow and its modeling.

Learning Outcomes



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Upon successful completion of this course, students will:

- Understand the dynamics of viscous fluid flow, differential and integral forms of governing equations.
- Develop the ability to solve the N-S equations for various steady and unsteady flow situations.
- Develop the concept of hydrodynamic boundary layer with and without pressure gradient.
- Understand the phenomena of flow separation, drag and lift.
- Understand the scales of turbulence, Reynolds averaging techniques, and turbulence modelling in external and internal turbulent flows.
- Understand the multi-phase flow patterns, pressure drop, and volume fraction computations.
- Understand the multi-phase interactions, and modelling methods in multiphase flow.

Unit No	Topics	Learning Outcome	Content compared with Which University
1.	Dynamics of viscous fluid flow: Introduction to vector and tensor algebra, Fluid as a continuum, Kinematics of fluid flow, Reynolds Transport theorem, Derivation of Navier Stokes equations and some exact solutions for steady and unsteady flows, Creeping flow & lubrication theory.	<ul style="list-style-type: none"> • Understand the dynamics of viscous fluid flow, differential and integral forms of governing equations. • Develop the ability to solve the N-S equations for various steady and unsteady situations. 	IIT Kharagpur IIT Guwahati IISC Bangalore
2.	Boundary layer theory: Introduction to laminar boundary layer (external and internal boundary layers), boundary layer equations, BL with zero and non-zero pressure gradient, different measures of boundary layer thickness, Blasius solution for boundary layer on a flat plate, Von Karman momentum integral equation of boundary layer, boundary layer separation, description of flow past cylinders and spheres, concept of drag and lift.	<ul style="list-style-type: none"> • Develop the concept of hydrodynamic boundary layer with and without pressure gradient. • Understand the phenomena of flow separation, drag and lift. 	IISC Bangalore IIT Kharagpur IIT Guwahati IIT Delhi
3.	Introduction to turbulent flow: Scales of Turbulence, Energy cascading, Kolmogorov scale, Vorticity transport equation, vortex stretching, Statistical distribution of turbulence, averaging techniques, Reynolds decomposition, Continuity equation	<ul style="list-style-type: none"> • Understand the scales of turbulence, and Reynolds averaging techniques in external and 	

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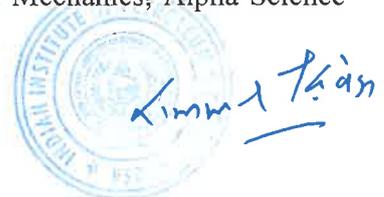
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Department of Mechanical Engineering

	<p>and Reynolds average Navier Stoke equation, Reynolds stress and Boussinesq's eddy viscosity hypothesis approximation, Turbulent kinetic energy, dissipation rate and turbulent intensity. External turbulent flows: Analysis of Flow over a flat plate under steady, and incompressible condition, modelling of turbulent viscosity, Prandtl's mixing length hypothesis, Universal turbulent velocity profile, law of wall, Integral solutions for turbulent boundary layer, $1/7^{\text{th}}$ law of velocity profile. Internal turbulent flow: Concept of entry length and governing equations, Turbulence modelling: Standard $k-\epsilon$ model, RNG $k-\epsilon$ model and $k-\omega$ model, concept of wall function.</p>	<p>internal turbulent flows.</p> <ul style="list-style-type: none"> Understand the turbulence modelling through different turbulence models. 	<p>IIT Kharagpur IIT Guwahati</p>
4.	<p>Introduction to Multiphase flow: Introduction to multiphase flow, Fundamental definitions and terminologies, Flow pattern map for fluid-fluid and fluid-solid flow, pressure drop and volume fraction calculation for Homogeneous regimes: Using momentum balance equation from equation of motion and empirical correlations, Pressure drop and Volume fraction calculation for Segregated/Separated regimes: Using equation of motion and empirical correlations. Multiphase Interactions: Drag, lift, virtual mass force, Basset force, one way, two way, three-way and four-way coupling and mathematical formulation of the same, Modelling Methods for Multiphase Flows: Mixture Model, Euler-Euler Model and Euler-Lagrangian Model. Fundamentals of Gas-solid two-phase flow & slurry flow.</p>	<ul style="list-style-type: none"> Understand the multi-phase flow patterns, pressure drop, and volume fraction computations. Understand the multi-phase interactions, and modelling methods in multiphase flow. 	<p>IIT Kharagpur IIT Roorkee IIT Guwahati</p>

Text Book:

1. P. K. Kundu, I. M. Cohen, and D. R. Dowling, Fluid mechanics, Academic press, 2015.
2. K. Muralidhar, and G. Biswas, Advanced Engineering Fluid Mechanics, Alpha Science Int'l Ltd., 2005.



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Reference books:

1. R.L. Panton, Incompressible Flow, Wiley, 4th Edition, 2013.
2. C.T. Crowe, Multiphase Flow Handbook, CRC Press, 2005.
3. C. E. Brennen, Fundamentals of multiphase flow, Cambridge University Press, 2005.
4. L.S. Fan, and C. Zhu, Principles of gas-solid flows, Cambridge University Press, 1999.
5. G. Wallis, One Dimensional Two Phase Flows, Mc-Graw Hill, 1969.
6. F.M. White, Fluid Mechanics, McGraw-Hill (India) Ltd., 8th edition

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		Advanced Heat Transfer	3	1	0	4

Name of the Faculty	Dr. Santosh Kumar Senapati	Scheme of Evaluation	
Designation	Assistant Professor	Assignment+Attendance	20 Marks
Year/Semester	I/II	Mid Semester Examination	30 Marks
UG/PG/Ph.D.	PG/Ph.D.	End Semester Examination	50 Marks
Branch	All Engineering	Total	100 Marks

Course Objective

- To understand, and apply the analytical and numerical techniques to solve the multi-dimensional and unsteady heat conduction problems.
- To understand, apply and analyze the radiation heat transfer in participating and non-participating medium.
- To analyze the the forced convection in external and internal flows.
- To understand and analyze the natural convection heat transfer in different geometries.
- To understand, and apply the two-phase flow heat transfer with and without phase change.

Learning Outcomes

Upon successful completion of this course, students will:

- Understand multi-dimensional and unsteady heat conduction with and without the phase change and various solution techniques.
- Understand the radiation heat transfer in participating and non-participating medium.
- Develop the understanding of the numerical methods in radiation heat transfer.
- Understand the forced convection in external and internal flows.
- Develop the concept of forced convection in thermal entrance region and fully developed regions.
- Understand the natural convection in various geometries.
- Understand the combined forced and free convection.
- Understand the heat transfer in two-phase flow situations with and without phase change.
- Understand the various modes of heat transfer in gas-solid flows.

Unit No	Topics	Learning Outcome	Content compared with
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			Which University
1.	Conduction: Review of conduction heat transfer, analytical and numerical methods in multi-dimensional and unsteady conduction heat transfer, conduction with change of phase.	<ul style="list-style-type: none"> Understand multi-dimensional and unsteady heat conduction with and without the phase change and various solution techniques. 	IIT Kharagpur IIT Guwahati
2.	Radiation: A review black body radiation, laws of radiation, radiation heat transfer between surfaces, view factor algebra, radiation in participating media, concept of mean beam length, enclosure analysis in the presence of absorbing/emitting gases, emissivity and absorptivity of gas mixtures, numerical methods in radiation heat transfer.	<ul style="list-style-type: none"> Understand the radiation heat transfer in participating and non-participating medium. Develop the understanding of the numerical methods in radiation heat transfer. 	IIT Madras IIT Roorkee
3.	Forced Convection: A review of viscous flow, the continuity and Navier-Stokes equation, boundary layer equation, laminar boundary layer over a flat plate, Energy equation, derivation of energy equation, energy equation in non-dimensional form, derivation of thermal boundary layer equation, heat transfer in a parallel flow over a flat surface, analogy between momentum and heat transfer in turbulent flow, forced convection in internal flows, concept of entrance length and fully developed flow, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Graetz solution).	<ul style="list-style-type: none"> Understand the forced convection in external and internal flows. Develop the concept of forced convection in thermal entrance region and fully developed regions. 	IIT Kharagpur IIT Guwahati IIT Madras
4.	Free Convection: Scaling analysis, laminar flow over a vertical plate, empirical co-relation in external free	<ul style="list-style-type: none"> Understand the natural convection in various geometries. 	IIT Kharagpur IIT Guwahati IIT Madras

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	convection flows, inclined plates, long horizontal cylinder, spheres, free convection in enclosures, and cavities, concentric cylinders, concentric spheres, combined free and forced convection.	<ul style="list-style-type: none">Understand the combined forced and free convection.	
5	Heat Transfer in two-phase flow: Two-phase flow with phase change, pool boiling and flow boiling, Different regimes of pool boiling, bubble growth, Dropwise and film wise condensations, Heat transfer in gas-solid systems, Fluidized bed.	<ul style="list-style-type: none">Understand the heat transfer in two-phase flow situations with and without phase change.understand the various modes of heat transfer in gas-solid flows.	IIT kharagpur IIT Roorkee

Text Book:

1. M N Ozisik, Heat Conduction, 2nd ed, John Wiley & Sons, 1993.
2. M F Modest, Radiative Heat Transfer, McGraw-Hill, 1993.
3. W. M. Kays, E. M. Crawford, and B. Weigand, Convective Heat and Mass Transfer, Tata McGraw Hill, 4th Edition, 2012.
4. F P Incropera and D P Dewitt, Introduction to Heat Transfer, 3rd ed, John Wiley & Sons, 1996.

Reference books:

1. R Siegel and J R Howell, Thermal Radiation Heat Transfer, 3rd ed, Taylor & Francis, 1992
2. Adrian Bejan, Convective Heat Transfer, John Wiley and Sons, 4th Edition, 2013.
3. L.S. Tong and Y.S. Tang, Boiling Heat Transfer and Two-Phase Flow, 2nd ed., Taylor and Francis, 1997.
4. A. Cengel, Heat transfer, McGraw-Hill, 2003.
5. H. K. Versteeg, and W. Malalasekera, An Introduction to Computational fluid dynamics: The finite volume method, Pearson, 1995.

PHD COURSE

FACULTY NAME: Dr. Nagesh Geddada

Request for subject name change: To change the title of the PhD Course from "Power Quality Improvement Technique" to "Power Quality in Power Distribution System".

Course Type	Course Code	Name of Course	L	T	P	Credit

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Core		Power Quality in Power Distribution System	2	1	0	3
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Course Objective

- To develop knowledge on single phase and three phase balanced and unbalanced distribution network. To familiarize about various electrical parameters/quantities used in power distribution network.
- To develop knowledge on power quality aspects and its improvement using load compensation methodologies/techniques in distribution network.

Learning Outcomes

- Significance of maintenance of power quality in distribution network within the allowable range. Load compensation using passive impedance.
- Active devices used for improvement of power quality and the theories/ methodologies adopted for control and operation of these devices.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome	Content compared with Which University
1.	Single Phase Circuits: Introduction, Power Terms in a Single Phase System, Sinusoidal Voltage, Concept of Source Supplying Non-linear Load Current and Non-Sinusoidal Voltage Source Supplying Non-linear Loads, Various parameters Active Power, Reactive Power, Apparent Power, Non Active Power, Distortion Power, Fundamental Power Factor, Power Factor.	40	<ul style="list-style-type: none"> • Significance of maintenance of power quality in distribution network within the allowable range. Load compensation using passive impedance. 	IIT Madras
2.	Three Phase Circuits: Three-phase Sinusoidal Balanced System, Three Phase Instantaneous Active Power and Reactive Power, Symmetrical components, Effective Apparent Power, Positive Sequence Powers and Unbalance Power, Three-phase Non-Sinusoidal Balanced System. Numerical problems for calculation of various parameters.		<ul style="list-style-type: none"> • Devices used for improvement of power quality and the theories/ methodologies adopted for control and operation of these devices. 	
3.	Fundamental Theory of Load Compensation: Load Compensation, Power Factor and its Correction, Voltage Regulation, Phase Balancing and Power			



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Department of Mechanical Engineering

4.	Factor Correction of Unbalanced Loads, A Generalized Approach for Load Compensation using Symmetrical Components. Control Theories for Load Compensation: State Space Modelling of the Compensator, Switching Control of the VSI, maintenance of dc capacitor voltage, Computation of load average power, Theory of Instantaneous Symmetrical Components.			
5.	Voltage Compensation Using DVR: Conventional Methods to Regulate Voltage, Dynamic Voltage Restorer (DVR), Operating Principle of DVR, Mathematical Description to Compute DVR Voltage, Transient Operation of the DVR.			
Total Classes		40		

Text/Reference Books:

1. A. Ghosh and Gerard Ledwich 'Power Quality Enhancement Using Custom Power Devices (Power Electronics and Power Systems)', Springer; 2002.
2. S. Santoso, H. W. Beaty, R. C. Dugan, and M. F. McGranaghan, 'Electrical Power Systems Quality', McGraw-Hill Professional, 2002.
3. Hirofumi Akagi, E. H. Watanabe and Mauricio Aredes, 'Instantaneous Power Theory and Applications to Power Conditioning ', Wiley-Interscience, A John Wiley and Sons, Inc., Publications.



A. Kumar & P. S. Rao

24.04.2024

1977-1980
1981-1984
1985-1988
1989-1992

Sub.: Syllabus of “Advanced Air Pollution Control” (For PG and Ph.D. students)

Faculty name: Ravi Kumar Sonwani (Assistant Professor; Dept. of Chemical Engineering, IPE, Visakhapatnam)

Course Type	Course Code	Name of Course	L	T	P	Credit
Elective	-	Advanced Air Pollution Control	4	0	0	4
Objectives:						
1. To provide the basic and advanced aspects of Air Pollution and its Control Technologies.						
Learning Outcomes						
1. Learn the basic scheme, legal requirements, appropriate mitigation and treatment technologies for Air Pollution Control.						
2. Learn various modelling, economic aspects, and case studies of Air Pollution Control.						
Unit No.	Topics to be Covered	Learning Outcome	Content compared with Which University			
1.	Introduction Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect. Overview of current air pollution problems from local to continental scales.	Understand the major sources of air pollution and their adverse effects.	Universidad del Pais Vasco, Spain. IIT Kharagpur, India			
2.	Transport and dispersion of air pollutants Atmospheric chemistry, Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns, Atmospheric diffusion theories, Dispersion models, Plume rise.	Understand the metrological aspects and dispersion models				
3.	Control of particulate & gaseous contaminants: Monitoring of emissions and air pollutants in ambient air,	Learn air pollution control strategies				



Dimant P. S.
24.04.2022

	Factors affecting selection of Control Equipment, Working principle of Air Pollution Control Equipments.		
4.	Indoor air quality management: Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness, Control and Preventive measures.	Learn fundamental aspects of indoor air pollution & its preventive measure	
5.	Case studies and economics: Economics and trends in air pollution control. Case studies.	Economic and case studies associated with air pollution control	

Text Book:

1. H.S. Peavy, D. R. Rowe, G. Tchobanoglous, Environmental Engineering, McGraw-Hill (1985).
2. Noel de Nevers, Air Pollution Control Engineering, Waveland Press, Inc (2010).

Reference

3. Richard C. Flagan, John H. Seinfeld, Fundamentals of Air Pollution Engineering. Prentice Hall (1988).

Advanced Separation and transport in Energy systems

Faculty: Dr. Raka Mondal, Chemical Engg Department

Course Type	Course Code	Name of Course	L	T	P	Credit
Elective for PhD (any department) and final year B.Tech. (Chemical Engineering)		Advanced Separation and transport in Energy systems	3	1	0	3
Course Objective						



1. To make the students understand the advanced concepts of mass transfer systems.
2. To enable the students to grasp advanced knowledge in coupled separation processes.
3. To enhance the comprehensive ability among students to design state of the art separation technologies.

Learning Outcomes

- At the end of the course, the student will be able to:
1. Comprehend the principles of complex fluid separation processes including advanced mass transfer and diffusion theories,
 2. Understand equilibrium-based and rate-based methods/models for multi-component absorption, stripping, distillation and extraction, temperature-/pressure-swing adsorption, advanced ion exchange adsorption and chromatographic separation.
 3. Develop advanced knowledge for design and operation of industrial separation units,
 4. Enhance skill of using simulation tools applicable for multicomponent separation, and to analyse the energy efficiency, cost-effectiveness and sustainability of the design solutions.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome	Content compared with Which University
1	Separation Process fundamentals	4	<ul style="list-style-type: none"> • Separation processes in chemical industries, • Categorization of separation processes, • Equilibrium and rate governed processes, • Thermodynamics of separation systems. 	IITs
2	Membrane based separation processes	5	<ul style="list-style-type: none"> • Forward and for liquid systems. • Gas filtration system • External field enhanced membrane filtration s • Surfactant based and micellar enhanced separation 	IITs
3	Advanced adsorption Systems	4	<ul style="list-style-type: none"> • Adsorbents and adsorption Kinetics and Equilibrium • Solute transport analysis for linear systems • PSA, TSA, SMB • Fluid, Mass and energy transfer • Traditional modelling approach • Scale up study 	IITs



Kimul Das

4	Supercritical fluid extraction and centrifugal separation	4	<ul style="list-style-type: none"> • SCF solvent • SCF techniques • Settling rates in centrifuge • Separation of liquids 	IITs
5	Electric Field Enhanced Separation Process	4	<ul style="list-style-type: none"> • Fundamentals • Potential distributions • Electrophoresis • Coupled systems 	IITs
6	Transport in solid electrolyte In fuel cell systems	5	<ul style="list-style-type: none"> • Classification • Application and mechanism • Coupled transport systems modelling 	MIT (Open Courseware)
7	Transport in solid electrolyte In electrolyser	5	<ul style="list-style-type: none"> • Classification • Application and mechanism • Coupled transport systems modelling 	MIT (Open Courseware)
8	Photolysis and photocatalysis	5	<ul style="list-style-type: none"> • Basics • Kinetics • Coupled transport systems • Optimisation and scale-up 	MIT (Open Courseware)

Text Books

- Separation Process Principles, Ernest J. Henley, J. D. Seader, D. Keith Roper, Wiley.

Reference Books

- Membrane Technology and Applications by Author(s):Richard W. Baker; Wiley.
- Marcel Mulder, "Basic Principles of Membrane Technology", 2 Ed., Springer Publications, 2007
- P. C. Wankat, "Rate- Controlled Separations", Springer, 1994.
- Nunes. S.P, Peinemann, K.V, "Membrane Technology in the chemical industry", 2nd Edition, Wiley-VCH, 2006.
- 2. Rautanbach and Albrecht. R., "Membrane Process", John Wiley and Sons.1989.
- 3. Crespo. J.G., Bodekes, K.W., "Membrane Processes in separation and Purification", Kluwer Academic Publications, Netherland, 1994.
- 4. Geankoplis. C.J. "Transport processes and Unit Operations", 4th Edition, PHI, New Delhi, 2006.



PG/PhD course	Mathematical methods in Chemical Engineering	Credits
		3-1-0: 4

Faculty name: Dr. Venkata Reddy Palleti, Chemical Engineering

Pre-Requisites: Course on Engineering Mathematics at Undergraduate Level

Objective:

This course is designed to impart knowledge of advanced mathematical techniques applicable for solving Chemical Engineering problems.

Course Outcomes:

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

1. Formulate and solve eigenvalue problems and interest stability aspects.
2. Understand and solve homogeneous and non-homogeneous partial differential equations analytically.
3. Appreciate the approximations in various transport equations and solve using similarity/ integral method

Syllabus:

Introduction of vector space metric, norm, inner product, onto, into, one to one function, completeness of space. Linear combination of vectors, dependent/independent vectors, orthogonal and orthonormal vectors, gram-schmidt orthogonalization. Matrix, determinants and properties.

Eigenvalue problem: Various theorems; solution of a set of algebraic equations; solution of a set of ordinary differential equations; solution of a set of nonhomogeneous first order ordinary differential equations (ivps), applications of eigenvalue problems: stability analysis; bifurcation theory

Differential Equations: Classification of equations; Boundary conditions; Principle of Linear superposition, Special ODEs and Adjoint operators: Properties of adjoint operator; Sturm Luiville theorem for eigenvalues and eigenfunctions.

Solution of linear, homogeneous PDEs by separation of variables: Cartesian coordinate system & different classes of PDEs; cylindrical coordinate system; spherical coordinate system; Solution of PDEs by different methods, Solution of PDEs by Similarity solution method, Solution of PDEs by Integral method

Transformations: Solution of PDEs by Laplace transformation, Solution of PDEs by Fourier transformation

Text books:

1. Mathematical Methods in Chemical Engineering by S. Pushpavanam, Prentice Hall of India.
2. Applied Mathematics in Chemical Engineering by Mickley, Sherwood and Reed, Tata McGraw-Hill

Reference books:

1. Applied Mathematics and Modeling for Chemical Engineers by R. G. Rice & D. D. Do, Wiley.



Amma Tias

24.04.2024

REGISTRAR

INDIAN INSTITUTE OF PETROLEUM & ENERGY
VISAKHAPATNAM

To,

The Director
 Indian Institute of Petroleum and Energy
 Visakhapatnam (A.P.) - 530083

Subject - Appealing to reconsider the decision of Grievance Committee

Respected Sir,

I am J.D. Sandeep of 3rd year, B.Tech. Chemical Engineering. I have received a mail regarding Resolution of Grievance Committee meeting that the examination in all papers of Sixth semester are cancelled and I will not be allowed to appear in supplementary examination. Sir, I understand this is my 2nd time doing malpractice in the examination but respectfully this time I did not have the intention to copy in the examination. I unintentionally kept the phone in pocket. I was not aware until it rang in the examination hall. After first Disciplinary Committee (D.C.), I have not tried to carry any slips or gadgets in any examination. I am going to enter final year and I cannot re-register all subjects of Sixth semester and eighth semester together due to credit limit per semester. Due to this I will not be able to complete my degree in four years. This was purely unintentional mistake from my side. I request you to reconsider the decision.

Therefore, it is my humble request from my side to look forward to the decision and do the needful.

Thanking you,
 Yours sincerely,
 J.D. Sandeep
 21CH10030

Ph.No. - 9347850148

Forwarded by
 P. Venkatesh
 12/04/24

Sir
 Received an appeal from
 Mr. J.D. Sandeep to reconsider
 the decision. Forwarding
 for guidance.

To be placed in file
 15/4/24



INDIAN INSTITUTE OF PETROLEUM AND ENERGY

2ND Floor, Main Building, AU College of Engineering

Visakhapatnam – 530003

Tele: 0891-2585152, Website : www.iipe.ac.in, Email : office@iipe.ac.in

Ref: IIPE/Exam/824

Date: 08-04-2024

MINUTES OF THE GRIEVANCES COMMITTEE MEETING HELD ON 08-04-2024

A meeting of the Grievances Committee was held on 8th April 2024 in Room No: 301 (Dr. APJ Abdul Kalam Conference Hall) at 04:00 PM to discuss and comply with the unfair means (UFM) which was reported during the End Semester Examination (Spring 2023-24).

MEMBERS PRESENT:

Sl No	Name of faculty	Signature
1	Prof. Shalivahan, Director	
2	Prof. Deepak Amban Mishra, DOAA	
3	Prof. Himangshu Kakati, PIC, Examinations	
4	Prof. Sridhar Palla, Member and Invigilator	

DELIBERATIONS AND RESOLUTION:

Following a concise deliberation, the committee has proposed the following subsequent disciplinary measures to be taken against individual reported for engaging in unfair practices during the Spring Semester 2023-24 end-examinations.

S. No.	Act of Misconduct	Resolution of the committee
1	Mr. J Durga Sandeep, 21CH10030 was caught with mobile phone in his pocket during the end-term examination held on 03-03-2024 for the course 'Computer Aided Process Engineering.	It is resolved that the examination in all papers of the Semester shall be cancelled and the student shall be declared failed in the Examination and the student shall not be allowed to appear in the Supplementary Examination.

The committee emphasizes that the above disciplinary actions are taken to maintain the academic integrity of the Institution and prevent the recurrence of such misconduct in the future.

To
The Concerned Student
The Members of the Committee and Course Instructor
Student Files and Examination Section

The Resolution is as per the approved guidelines. Approved guidelines attached. 08/04/2024

S. NO.	THE NATURE OF UNFAIR MEANS ADOPTED	PUNISHMENT TO BE AWARDED
1.	<p>(a) When incriminating material has been found in the possession of the examinee.</p> <p>(b) When a student tries to copy from other student's answer book, talks to other students, tries to exchange answer book/question paper/ calculators, tries to pass on information in any form.</p>	<p>Examination in that subject shall be cancelled. In the event of unfair means being adopted in an End-Semester Examination, the student(s) may be allowed to clear the subject by appearing in the Supplementary Examination.</p> <p>In the event of the unfair means being adopted in a Supplementary Examination, the student shall be declared failed in the Examination. If unfair means are adopted in mid semester examinations, students will not be allowed to re-write the mid exam.</p> <p>Examination in the subject as well as in all other subjects of the semester shall be cancelled and the student shall be declared failed in all the subjects of the Semester.</p>
2.	<p>(a) When incriminating material related to the question paper has been found in the possession of an examinee he/she copied it in part or full when the examinee refused to be searched, if so desired by the Center Superintendent/Invigilator and does not accept the fault</p> <p>(b) When a student tries to copy from other students' answer books, talks to other students, tries to exchange answer books/ question papers/ calculators or tries to pass on information in any form and does not accept the fault when challenged and /or into arguments with the invigilator(s).</p>	<p>In the event of unfair means being adopted in the End-Semester Examination, the student may be allowed to clear the semester by appearing at a Supplementary Examination in all the subjects.</p> <p>In the event of the unfair means being adopted in a Supplementary Examination, the student shall be declared failed in the Examination. If unfair means are adopted in mid semester examinations, students will not be allowed to re-write the mid exam.</p>
3.	<p>(a) When incriminating material has been found in the possession of an examinee who was found guilty of using unfair means on an earlier occasion; or</p> <p>(b) When incriminating material has been found in the possession of an examinee, and the examinee has been caught for use of unfair means on the earlier occasion of the same End-Semester/Special Examination; or,</p> <p>(c) When the incriminating material comprises the answer book/additional sheet stolen earlier and/or when the examinee tries to destroy the material, and/or when the examinee tries to tear the answer book, and/or instigate/disturb others in the Examination hall to support his cause.</p>	<p>Examination in all papers of the Semester shall be cancelled and the student shall be declared failed in the Examination. In addition, the student may be rusticated for a period of one year. In the event of unfair means being adopted in an End-Semester Examination, the student shall not be allowed to appear in the Special Examination.</p>
4.	<p>When the use of unfair means has been attempted or where incriminating material has been found in the possession of the examinee, and the examinee has misbehaved with the faculty or staff on Examination supervision duty.</p>	<p>Examination in all papers of the semester shall be cancelled and the student shall be expelled from the Institute.</p>
5.	<p>Other Cases -- (if any)</p>	<p>As per the mutual decision taken by the pra-practice disciplinary committee with the permission of the chair.</p>

Note: In addition, if found guilty, the student may not be eligible for any scholarship/fellowships, etc.

Date; 28-03-2024

To
The Director
IPE, Visakhapatnam

Dear Sir,

I am writing to seek your approval for a proposal to the eligibility criteria for admission into Ph.D. programme under Institute Assistantship.

For notification of the Ph.D. Programme, the following point going to be included as a eligibility criteria for Institute Research Assistantship.

"Candidates with a M.Tech. degree in Engineering or Technology after qualifying GATE is also eligible for Institute Research Assistantship".

I kindly request your approval for this point for eligibility for Ph.D. Admission.

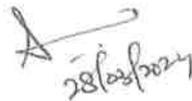
With regard,



PIC, Ph.D. Admissions

His
Request may be considered.


APPROVED. To be notified in the sense


28/03/2024