INDIAN INSTITUTE OF TECHNOLOGY MANDI

KAMAND, DISTT. MANDI – 175075 (HIMACHAL PRADESH)

MINUTES OF 50TH BOARD OF ACADEMICS MEETING

VENUE	:	GUEST HOUSE (NC)CONFERENCE ROOM + ONLINE
DATE	:	14TH JULY, 2023 (TUESDAY)
TIME	:	4:00 P.M.

Following members attended the meeting

Sl. No	Responsibilities	Name
1	Dean Academics	Prof. Aniruddha Chakraborty
2	Associate Dean (Research)	Dr. Amit Jaiswal
3	Associate Dean (Courses)	Dr. P. Anil Kishan
4	Chairman Senate Library Committee	Prof. Aniruddha Chakraborty
5	Chairman Course Proposal Committee	Dr. Venkata Uday Kala
6	Nominee-1: School of Computing and Electrical Engineering	Dr. Padmanabhan Rajan
7	Nominee-2: School of Computing and Electrical Engineering	Dr. Gopi Shrikanth Reddy
8	Nominee-1: School of Biosciences and Bioengineering	Dr. Sumit Murab
9	Nominee-2: School of Biosciences and Bioengineering	Dr. Kasturi Prasad
10	Nominee-1: School of Mathematical and Statistical Sciences	Dr. Rajendra K Ray
11	Nominee-2: School of Mathematical and Statistical Sciences	Dr. Syed Abbas
12	Nominee-1: School of Civil and Environmental Engineering	Dr. Maheshreddy Gade
13	Nominee-1: School of Mechanical and Materials Engineering	Dr. Gaurav Bhutani
14	Nominee-1: Centre of AI and Robotics	Dr. Narendra Kumar Dhar
15	Nominee-2: Centre of AI and Robotics	Dr. Jagadeesh
16	Nominee-1: IKSHMA	Dr. Aniruddha Chakraborty
17	Nominee-2: IKSHMA	Dr. Sumit Murab
18	Deputy Registrar (Academics): Secretary	Mr. Suresh Rohilla

Following members could not attend the meeting

Sl. No.		Name	
1	Nominee-1: School of Physical Sciences	Dr. Arko Roy	Member
2	Nominee-2: School of Physical Sciences	Dr. Girish Sharma	Member
3	Nominee-1: School of Chemical Sciences	Dr. Bhaskar Mondal	Member
4	Nominee-2: School of Chemical Sciences	Dr. Garima Agrawal	Member
5	Nominee-2: School of Civil and Environmental Engineering	Dr. Prasanna Rousseau	Member
6	Nominee-2: School of Mechanical and Materials Engineering	Dr. Sudhir Pandey	Member
7	Nominee-1: School of Humanities & Social Sciences	Dr. Rajeshwari Dutt	Member
8	Nominee-2: School of Humanities & Social Sciences	Dr. Ramna Thakur	Member
9	Industry Member – 1	Dr. Nadeem Akhtar	Member
10	Research Affairs Secretary	Mr. Shubham Ranjan	Member
11	Academic Affairs Secretary	Ms. Dishti Oberai	Member

Special Invitee

Sl. No.	Name	
1	Dr. C.S.Yadav	Asso. Prof. SPS
2	Dr. Dericks P. Shukla	Asso. Prof. SCENE
3	Prof. Manoj Thakur	Prof., SMSS
4	Dr. Tushar Jain	Asso. Prof. SCEE
5	Prof. Suman K Pal	Prof., SPS
6	Dr. Shyamasree Dasgupta	Asso. Prof. SHSS

PART-A

(Issues discussed by the Board of Academics when the Student Members were present)

50.1 Confirmation of the minutes of 49th meeting of the Board of Academics:

The minutes of the 49th meeting of the Board of Academics held on 28th March, 2023 were confirmed.

50.2 To consider courses pending with CPC:

Dr. Venkata Uday Kala, Chair CPC presented the proposal of pending courses to the Board of Academics. After due deliberations, the BoA approved the following courses with minor modification and the same shall be reported to the Senate.

The course descriptions are placed as **Annexure – A.**

Sl.No.	Course No.	Name	Credits
1	AR-501	Robot Kinematics, Dynamics, and Control	3-1-0-4
2	AR-502	Advanced Design Practicum	3-0-3-4
3	AR-503	Mechatronics	3-0-0-3
4	AR-504	Robot Programming, Modeling, and Simulation	2-0-2-3
5	AR-505	Principles of Robot Autonomy	3-0-0-3
6	AR-506	Cognitive Robotics	3-0-0-3
7	AR-507	Probabilistic Robotics	3-0-0-3
8	AR-508	Marine Robotics	3-0-0-3
9	AR-509	Deep Learning for Robotics	3-0-2-4
10	AR-510	Underactuated Robotics	3-0-0-3
11	AR-511	Autonomous Mobile Robots	3-0-0-3
12	AR-512	Rapid Prototyping and Tooling	3-0-2-4
13	AR-513	Unmanned Aerial Systems	3-0-0-3
14	AR-514	Vision and Learning Based Control	3-0-0-3
15	AR-515	Sensors and State Estimation	3-0-0-3
16	BE-306	Genetic Engineering: Principles and Applications	3-1-0-4
17	BE-307P	Reverse Engineering for Bioengineers	0-0-2-1
18	BE-308	Introduction to Biomanufacturing	3-0-2-4
19	BE-401	Bioengineering Mini Project, Term Paper and Seminar	0-0-8-4
20	BE-507	Tissue Engineering	3-0-0-3
21	BY-509	Practical OMICs	0.5-0.5-2-3
22	CE-515	Environmental Impact Assessment	3-0-0-3
23	CE-516	Uncertainty Analysis in Civil Engineering	3-0-0-3
24	CE-517	Hydroinformatics	3-1-0-4
25	CE-518	Structural Reliability and Risk Assessment	3-0-0-3
26	CE519	Chemistry of Natural Waters	3-0-0-3
27	CE-613	Mechanics of Unsaturated Soils	3-0-0-3
28	CS-516P	Exploratory Project	0-0-6-3
29	CY-524	Basic and Applied Electrochemistry	3-0-0-3
30	EE-541	Tensors: Techniques, Algorithms, Applications for Signal Processing, and Machine Learning	3-0-2-4
31	EE-542	Modelling, Simulation and Control of Hybrid Electric Vehicle	3-0-0-3

32	EE-543	Vision and Learning Based Control	3-0-0-3
33	EP-502	Informatics for Materials Design	2-0-2-3
34	ET-504P	Systems Design for Electric Vehicles	0-0-3-2
35	HS-302	Introduction to Drama in English	3-0-0-3
36	HS-303	Partition of India: History and Legacy	3-0-0-3
37	HS-546	Readings in World Literature	3-0-0-3
38	HS-547	Philosophy of Texts and Narratives	3-0-0-3
39	HS-548	Science and Society	3-0-0-3
40	HS-549	Indian Literatures in English Translation	3-0-0-3
41	IC-102P	Foundations of Design Practicum	1-0-6-4
42	IC-112	Calculus	1.5-0.5-0-2
43	IC-113	Complex and Vector Calculus	1.5-0.5-0-2
44	IC-114	Linera Algebra	2-0-0-0
45	IC-115	ODE and Integral Transform	2-0-0-0
46	IK-501	Yoga sutras	2-0-1-3
47	IK-504	Bhagavad Gita - Comprehensive	3-0-0-3
48	IK-502	Introduction to Bio-signals	3-0-2-4
49	IK-503	Cognitive Psychology and the Indian Thought System	3-0-0-3
50	MA-528	Measure Theory and Integration	3-1-0-4
51	MA-529	Statistical Inference	3-1-0-4
52	MA-530	Graph Theory	3-1-0-4
53	MA-610	Mathematical Modeling	3-0-0-3
54	MA-611	Statistical tools and Computing	3-1-0-4
55	MB-510	Probability and Statistics for Data Science and AI	2-0-0-2
56	MB-511	Python Programming	2-0-0-2
57	MB-512	Mathematical Foundations for DS and AI	2-0-0-2
58	MB-513	Principles of Management	2-0-0-2
59	MB-514	Communication Skills for Managers	2-0-0-2
60	MB-515	Financial Statements Analysis	2-0-0-2
61	MB-516	Managerial Economics	2-0-0-2
62	MB-517	Marketing Management	2-0-0-2
63	MB-518	Decision analysis	2-0-0-2
64	MB-519	Creative Thinking, Problem Solving and Decision Making	2-0-0-2
65	ME-511	Manufacturing of Composites	3-0-0-3
66	ME-523	Product Design	3-0-0-3
67	ME-524	Additive Manufacturing	3-0-0-3
68	PH-608	Computer assisted quantum mechanics	2-0-3-3
69	PH-609	Theory of quantum collision and spectroscopy	3-0-0-3

50.3 To consider the proposal of B.Tech. semester wise distribution according to revised curriculum:

Respective School Chairs, presented the proposal of B.Tech. semester wise distribution to revised curriculum. After due deliberations, the BoA approved the proposal with minor modification and the same shall be reported to the Senate.

The modified proposal is placed as **Annexure – B.**

50.4 To consider the proposal to establish a new Centre for Climate Change and Disaster Management:

Dr. Venkata Uday Kala, presented a proposal to establish a new Centre for Climate Change and Disaster Management at IIT Mandi. After due deliberations, the BoA recommended the proposal for consideration of the Senate and its approval.

The modified proposal is placed as **Annexure – C.**

50.5 To consider the proposal of establish a new Centre for Quantum Technology:

Prof. Suman Kalyan Pal, presented a proposal to establish a new Centre for Quantum Technology at IIT Mandi. After due deliberations, the BoA recommended the proposal for consideration of the Senate and its approval.

The modified proposal is placed as **Annexure – D.**

50.6 Any other item with the permission of the Chair:

i. Dr. Amit Jaiswal, Associate Dean (Research) presented the proposal of Research Methodology (RM-600) course will be floated at the school level from the next semester starting January, 2024. The curriculum should be tailored to meet the research-related requirements specific to each school, and the evaluation of the course will also be conducted at the school level. The school is advised to take necessary action in this regard, prepare the revised curriculum, and seek the required approvals. After due deliberations, the BoA recommended the proposal for consideration of the Senate and its approval.

ii. Dr. P Anil Kishan, Associate Dean (Courses) presented the proposal of Preparatory courses to the Board of Academics. After due deliberations, the BoA approved the courses and the same shall be reported to the Senate. The proposal is placed as **Annexure – E.**

iii. Dr. Shyamasree Dasgupta, Chair SHSS presented the following proposal of revision in curriculum of Master of Arts in Development Studies (to be applicable from 2023-25 batch):

a) As a core course, HS528: Information Technology and Development will be replaced by HS532: Sustainable Development and Environmental Protection. HS528 will be moved to the Discipline Elective basket.
b) As a core course, the credit structure of HS522: Research Methodology for Humanities and Social Sciences (3-0-0-3 at present) will be modified as 4-0-0-4.
c) Total credits for core courses will be increased from 18 to 19 (due to modification in the credit structure of HS522).
d) The credit structure of DP554P Dissertation for Masters in Development Studies or Guided Internship (0-0-35-23 at present) will be modified as 0-0-33-22.
e) The revised credit distribution for semester 1 and 4 will be as follows (credits for Sem 2 and 3 remain unchanged) Sem 1 - 19 credits, Sem 4 - 22 credits.
f) Request to initiate a process to increase credits that could be taken from NPTEL/equivalent platform.

After due deliberations, the BoA approved the courses and the same shall be reported to the Senate.

PART-B

(Issues discussed by the BoA without the Student Members being present)

-NIL-

The meeting ended with a vote of thanks to and by the Chair.

Secretary, Board of Academics

Chairman, Board of Academics

Course Number : AR501/ ME452
Course Name : Robot Kinematics, Dynamics, and Control
Credit Distribution : 3-1-0-4
Intended for : UG, PG and Ph.D
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

This course will give students a complete understanding of not only how robots move (kinematics) but also why they move (dynamics). In this course, they will learn to develop the dynamics models of basic robotic systems, as well as create intelligent controllers for them. The students will learn several things. To name a few are: solve the dynamics for the motion of rigid bodies in 3D space, model the dynamics of a robotic system and derive its equations of motion, and create a full state feedback controller to allow a robotic system to balance.

2. Course Modules with quantitative lecture hours:

Introduction to Robotics: Basic definitions, mechanism, degree of freedom, Rigid Body Motions - Fundamentals, Classification of robots, actuators, sensors, and control systems. **(3 hours)**

Kinematics: Tracking Rigid Bodies (position and orientation), Coordinate transformation, Differential Kinematics, Kinematic Chains - Forward Kinematics (FK), Inverse Kinematics (IK), Differential Manipulator Kinematics. **(11 hours)**

Dynamics: Rigid Body Dynamics - Dynamics of Constrained Particles, Dynamics of a Rigid Body; Manipulator Dynamics - Dynamics of Serial Manipulators, Manipulator Dynamics with Constraints. **(11 hours)**

Trajectory generation: Determining the joint variables for desired trajectory. **(5 hours)**

Control: Fundamentals of Control - Linear Time Invariant Systems with Single Input and Output, Feedback Control and Stability, PID Controller, State Estimation in Feedback Systems; Manipulator Control - Local vs Centralized Motion Control Strategies, Indirect vs Direct Force Control Strategies. **(12 hours)**

Laboratory/practical/tutorial Modules:

Kinematics, Dynamics, Trajectory generation, Control

3. Textbooks:

1. Modern Robotics: Mechanics, Planning, and Control," Kevin M. Lynch and Frank C. Park, Cambridge University Press, 2017.
2. Craig John J., “Introduction to robotics: Mechanics & Control”, 3rd Ed., Pearson. 2008.
3. M. W. Spong and M. Vidyasagar, Robot Dynamics and Control, John Wiley, New York, 1989.
4. Murray R., Li Z., and Sastry S., *A Mathematical Introduction to Robotic Manipulation*, CRC Press.
5. Siciliano B., Sciavicco L., Villani L. and Oriolo G., *Robotics: Modeling, Planning and Control*, Springer.

4. References:

1. Ellis G., *Control System Design Guide*, Elsevier.
2. Jazar R. N., *Theory of Applied Robotics: Kinematics, Dynamics, and Control*, Springer.Moon F., Applied Dynamics, Wiley-VCH.

3. Astrom K. and Murray R., *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton.
4. Friedland B., *Control System Design: An Introduction to State-Space Methods*, Dover.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR502
Course Name : Advanced Design Practicum
Credit Distribution : 3-0-2-4
Intended for : PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

The course gives an outline of the steps in solving an engineering design problem through an example of a robot building. The course is multidisciplinary of its kind and will be used to bring out the multidisciplinary aspects of a typical engineering design problem. The course unravels the different steps of engineering problem solving culminating in the development of a robot.

2. Course Modules with quantitative lecture hours:

Introduction: Engineering design - How to select an engineering problem, stages of solving a problem, documentation in Engineering, Machine and a robot - Different aspects of robotics, current problems in robotics. Drives and motion, pneumatic, hydraulic systems, clutch and brake. **(3 hours)**

Practical 1: Microelectronics, onboard computer, IoT, embedded electronic and materials to be used in the lab Manufacturing techniques - additive and subtractive manufacturing. **(3 hours)**

Design of Mechanical Systems: Introduction to CAD by 3D modeling software, Drawing of parts and assemblies, Computer-Aided Manufacturing and prototyping, Brief Introduction to robotic systems, Joints and transformations on ROS. **(5 hours)**

Practical 2: Introduction to Mechanical assembly, bill of materials, 3D modeling software and design of parts and assemblies and Static Stress Simulation. **(3 hours)**

Practical 3: Simulation in ROS environment (**3 hours)**

Integration of Intelligent Control: Sensor and Actuator selection and sizing, Determination of Power Source, Design of Power distribution, microcontroller, and motor driver circuits, Developing PCB boards and feasibility testing, Introduction to standard electronic connectors and American Wire Gauge. **(7 hours)**

Practical 4: Sizing of sensors motors and linear actuators and integration into mechanical design. (3 hours)

Practical 5: Circuit Design using CAD tool and making PCBs manually and demonstration of CNC based PCB printing. (3 hours)

Programming and Signals: Introduction to Programming; procedural vs object-oriented programming, Object-Oriented programming in practice, Signals; communication via PWM, UART, Design of hardware and software interrupts. **(6 hours)**

Practical 6: Introduction to Programming; procedural vs object-oriented programming. **(3 hours)**

Practical 7: Signals; communication via PWM, UART; connecting two microcontrollers. **(3 hours)**

Practical 8: Design of hardware and software interrupts. **(3 hours)**

Integration of Compute and networks: Introduction to microcontroller coding and interfacing with the ros API, Introduction to ROS packages and their deployment, Introduction

to IoT and IP sending receiving packets on client-server networks, Control of robotic platforms over IP, Deployment of real-time decision pipelines on the robot. **(6 hours)**

Practical 9: Intro to rosserial and connecting microcontrollers to ROS. **(3 hours)**

Practical 10: Introduction to esp8266; control via blynk. **(3 hours)**

Practical 11: Deployment of conditional path planning on robot and testing. **(3 hours)**

Final project: Project towards design and development of functional Robotic system.

3. Textbooks:

1. Robot Builder's Cookbook - Owen Bishop
2. Autodesk Fusion 360- Gaurav Verma
3. Introduction to SOLIDWORKS: A Comprehensive Guide with Applications in 3D Printing - Godfrey C. Onwubolu

4. References:

1. Programming Robots with ROS - Morgan Quigley, Brian Gerkey

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR503
Course Name : Mechatronics
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

Students will be introduced to the main topics in the Mechatronics which blends the disciplines of mechanical engineering, computing, and electronics to create a huge range of electromechanical systems. It includes Introduction to the design of electromechanical systems. Interfacing sensors and actuators to a personal computer and a single-board computer. Electrical and mechanical design, prototyping, and construction. Dissection of a commercial mechatronic product. Students work in teams to produce final computer-controlled electromechanical projects of their own design.

2. Course Modules with quantitative lecture hours:

Introduction to Mechatronics: Introduction, Examples of Mechatronic systems, Electric circuits and components, Review of fundamentals of Electronics and its applications, Number systems: binary, hexadecimal and Review of C programming, CNC machines and Industrial Robots. **(4 hours)**

Mechatronics elements: Sensors and transducers, Displacement, Position & Proximity Sensors, Force, Fluid pressure, Liquid flow sensors, temperature, light sensor, Acceleration and, Vibration measurement, Performance terminology of sensors, Semiconductor sensors and micro-electromechanical systems (MEMS). **(8 hours)**

Microprocessors, microcontrollers, and Closed-loop controllers: Digital circuits, Microprocessors, Microcontrollers, Programming of Microcontrollers, P, I, PID Controllers, Digital Controllers, Program Logic Controllers, Input/output & Communication systems, Fault finding. **(4 hours)**

Signal conditioning: Introduction to signal processing, Op-Amp as a signal conditioner, Analog to Digital Converter, and Digital to Analog Converter. **(4 hours)**

Actuators, Drives, and mechanisms: Stepper motors, Actuators, Motor sizing, Power transmission: gears (rack and pinion, spur, planetary, worm, bevel, crown, harmonic) and belt drives; Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems. Torque, speed, and power equations, efficiency, and inertia. **(6 hours)**

Hydraulic and Pneumatic system: Flow, pressure, direction control valves, actuators, and supporting elements, hydraulic power packs, pumps, and design of hydraulic circuits. Pneumatic system production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. **(6 hours)**

Modelling and system response: Mechanical, Electrical, Fluid system modelling, Dynamic response, Transfer function and frequency response. **(6 hours)**

Final project on mechatronics: Group project towards design and fabrication of functional Mechatronics systems. **(4 hours)**

Laboratory/practical/tutorial Modules:

Microprocessors, microcontrollers, and Closed-loop controllers, Signal conditioning, Actuators, Drives, and mechanisms, Hydraulic and Pneumatic system, Modelling and system response.

3. Textbooks:

1. Bolton, William. Mechatronics: electronic control systems in mechanical and electrical engineering. Pearson Education.
2. Mahalik, Nitaigour Premchand. Mechatronics. Tata McGraw-Hill.
3. Bishop, Robert H. Mechatronics: an introduction. CRC Press.
4. Mechatronics system design by Devdas Shetty and Richard A. Kolk, Cengage Learning.
5. Mechatronics by G. Hegde, Jones and Bartlett.

4. References:

1. G.W. Kurtz, J.K. Schueller, P.W. Claar . II, Machine design for mobile and industrial applications, SAE.
2. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi.
3. T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall.
4. Embedded Computing and Mechatronics with the PIC32 Microcontroller, Kevin Lynch, Nicholas Marchuk, Matthew Elwin, Newnes.
5. R. Iserman, Mechatronic Systems: Fundamentals, Springer.
6. Musa Jouaneh, Fundamentals of Mechatronics, Cengage Learning.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR504
Course Name : Robot Programming, Modeling, and Simulation
Credit Distribution : 2-0-2-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

Students will be introduced to the main topics in context to the robot programming, robot modeling and simulation. The aim is to provide the students with the skills required to model the system of interest.

2. Course Modules with quantitative lecture hours:

ROS (Robot operating system): Prerequisites, basic structure, ROS master, ROS node, ROS topics, ROS msg, ROS bag record and play, rqt graph, rqt plot, ROS publisher, and subscriber node. **(10 hours)**

URDF modeling: Basic structure of urdf file, robot links and joints and its representation inside the urdf, writing urdf from scratch for a robot of interest, urdf test, and visualization. **(12 hours)**

Robot simulation environments: Brief description of various simulation platforms for robots. Demonstration in PyBullet and Gazebo. Import plane with zero and nonzero orientation. Import urdf of interest and fetch joint and pose info. Test the movement of interest in context to the model. Import multiple models in the simulation environments. **(10 hours)**

Robot control in the simulation environment: Automatic heading correction, robot navigation to the goal, and visual servoing. Case studies and course projects. **(10 hours)**

Laboratory/practical/tutorial Modules:

ROS, URDF modelling, Robot simulation environments, Robot control in the simulation environment

3. Textbooks:

1. Joseph L., Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System.
2. Quigley, Morgan, Brian Gerkey, and William D. Smart. *Programming Robots with ROS: a practical introduction to the Robot Operating System*. " O'Reilly Media, Inc.", 2015.

4. References:

1. ROS Tutorials by ROS.org

2. PyBulletQuickguide:
https://usermanual.wiki/Document/pybullet20quickstart20guide.479068914/html

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR505
Course Name : Principles of Robot Autonomy
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

Students will be introduced to the main topics that cover the basic principles for endowing mobile autonomous robots with perception, planning, and decision-making capabilities. Students will learn algorithmic approaches for robot perception, localization, and simultaneous localization and mapping as well as robot control.

2. Course Modules with quantitative lecture hours:

Introduction: Brief overview along with motivation and potential applications. **(1 hours)**

Robotic Perception: Robotic sensors, robotic sensor calibration and its importance, robot vision vs computer vision, robot localization, artificial neural networks for robot perception. **(16 hours)**

Robot Motion Planning: Overview, Configuration space, Free space, Target space, obstacle space, traditional and machine learning based planning algorithms. **(14 hours)**

Robot control: P, PI, PD and PID controller, visual servoing, and multi-robot control. **(11 hours)**

3. Text Books:

1. Choset, Howie, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, and Wolfram Burgard. *Principles of robot motion: theory, algorithms, and implementations*. MIT press, 2005.
2. Apolloni, Bruno, et al., eds. *Machine learning and robot perception*. Vol. 7. Springer Science & Business Media, 2005.

4. References:

1. Cuesta, Federico, and Aníbal Ollero. Intelligent mobile robot navigation. Vol. 16. Springer Science & Business Media, 2005.
2. Planning Algorithms by Steve LaValle (Cambridge Univ. Press, New York, 2006).
3. Mouha, Radouan Ait. "Deep Learning for Robotics." Journal of Data Analysis and Information Processing 9.02 (2021): 63.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR506
Course Name : Cognitive Robotics
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion : None

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1. Preamble:

Students will be introduced to the main topics in artificial cognitive systems, including the different paradigms of cognitive science and cognitive architectures. These components form the foundation for the remainder of the course, involving a detailed study of the CRAM (Cognitive Robot Abstract Machine) cognitive architecture, building on ROS, and exploiting functional programming to reason about and execute under-determined tasks in everyday activities.

2. Course Modules with quantitative lecture hours:

Introduction: Introduction to Cognitive Robotics and Human-Robot Interaction, Smart Materials. **(6 hours)**

Brain physiology and neural signal transmission: Architecture of the Brain, Nerve cells, Synchronization Models, Electroencephalography. **(6 hours)**

Intelligence architecture: Theories of Intelligence, Kuramoto Model, Child-Robot Interaction. **(10 hours)**

Artificial cognitive systems: Cognitive architectures, The CRAM cognitive architecture. **(10 hours)**

Functional programming: Robot manipulation and task-level robot programming using ROS, The CRAM plan language. **(10 hours)**

3. Textbooks:

1. Cangelosi A. and Asada M., *Cognitive Robotics*, The MIT Press, 2022.
2. Samani H., *Cognitive Robotics*, CRC Press, 2015.

4. References:

1. Purves D., et al., *Neuroscience*, Sinauer Associates, 2004.
2. Pfeifer R. and Bongard J., *How the body shapes the way we think-A New View of Intelligence*, MIT Press.
3. Raol J. R., and Ayyagari R., *Control Systems: Classical, Modern, and AI-Based Approaches*, CRC Press.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR507
Course Name : Probabilistic Robotics
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion : None

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1. Preamble:

This course will introduce various techniques for probabilistic state estimation and discuss their application to problems such as robot localization, and mapping.

2. Course Modules with quantitative lecture hours:

Introduction to Probability Theory and Linear Algebra: Sample space and events, Conditional probability, Expected value and variance. Uniform, normal, exponential random variables. Systems of linear equations, Linear dependence and independence, Operations with Matrices, Eigenvalues and eigenvectors. **(6 hours)**

Robot Motion: Probabilistic kinematics, Velocity motion model, Odometry motion model. **(4 hours)**

Sensors for robotics: Coordinate frame transformations**,** camera model, camera calibration, Sonar, Lidar, GPS, etc. **(5 hours)**

Recursive State Estimation: Bayesian filter, Kalman filter (KF), EKF, & Particle filter. **(11 hours)**

Robot Localization, Mapping, and SLAM: Localization problems, Markov localization, EKF localization, Grid localization, Monte Carlo localization, Occupancy grid mapping algorithm, EKF SLAM. **(16 hours)**

3. Textbooks:

1. Probabilistic Robotics. Sebastian Thrun, Wolfram Burgard and Dieter Fox. MIT press, 2005.
2. Papoulis A. and Pillai S. U., Probability, Random Variable, and Stochastic Processes.

4. References:

1. Probabilistic Robotics: http://www.probabilistic-robotics.org/
2. Strang G., Linear Algebra and its Applications.
3. Calculus: Elementary Linear Algebra by Ron Larson, 8th edition, Cengage Learning, 2017.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR508
Course Name : Marine Robotics
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

Students will be introduced to the main topics in the theoretical and practical design of marine robots such as autonomous underwater and surface vehicles (AUVs, ASVs). Students will be introduced to the theoretical principles underlying their design including aspects of guidance, navigation, and control, modelling and simulation. The module aims to provide the students with the skills required to design, build and deploy simple marine robotic systems.

2. Course Modules with quantitative lecture hours:

Types of Marine robots and applications: Introduction to the types of marine robots, Classification based on applications, Approach for deployment, operation and maintenance of marine robots such as surface vehicles and underwater vehicles (ASVs, AUVs, ROVs, underwater gliders and floats). **(4 hours)**

Vehicle design: Mechanical design of marine robots, structures, materials, pressure hull, Vehicle parameters and performance metrics including pressure, buoyancy, stability, ballasting, propulsion, power, speed, range, and cost of transport (COT). **(8 hours)**

Vehicle mathematical modelling: Classification of models, Rigid body Kinematics, frame transformations between body, flow, and non-accelerating frames, Euler angles, quaternions, Rigid-Body Kinetics, Equations of motion (Linear and nonlinear), Hydrostatics, maneuvering model, coupled motion model, environmental disturbances. **(8 hours)**

Navigation: Marine Sensors and navigational strategies for localization using dead-reckoning, SLAM and uncertainty/probabilistic approaches, and Observer-based design. **(6 hours)**

Guidance: Path planning algorithms and path following strategies include line of sight guidance strategies, pure pursuit guidance, constant bearing guidance, and trajectory tracking. **(6 hours)**

Control: Modelling and control using PID controllers, open-loop stability, and state feedback control, maneuverability system architectures, and actuator models. **(6 hours)**

Final project: Student project towards modelling of a marine robot using MATLAB. **(4 hours)**

3. Textbooks:

1. Handbook of Marine Craft Hydrodynamics and Motion Control 2nd Edition, Wiley.
2. Beard, R. W. and T. W. McLain. Small Unmanned Aircraft. Theory and Practice. Princeton University Press.
3. Moore S.W., Bohm H., and Jensen V. Underwater Robotics: Science, Design, and Fabrication.

4. References:

1. Triantafyllou MS, Franz S. Hover. Maneuvering and control of marine vehicles. Lecture Notes, Department of Ocean Engineering Massachusetts Institute of Technology Cambridge, Massachusetts USA.
2. Antonelli, G. Underwater robots. In Encyclopedia of Systems and Control (pp. 2384-2388). Cham: Springer International Publishing.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR509
Course Name : Deep Learning for Robotics
Credit Distribution : 3-0-2-4
Intended for : PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

Robotic platforms now deliver vast amounts of sensor data from large unstructured environments. In attempting to process and interpret this data there are many unique challenges in bridging the gap between pre-recorded datasets and the field. Deep learning has pushed success in many computer vision tasks through the use of standardized datasets. Beginning with understanding simple neural networks to explore long short-term memory (LSTM) and reinforcement learning, these modules will provide the foundations for using deep learning algorithms in many robotics workloads. This course will provide practical knowledge to apply supervised learning, derive backpropagation and use dropout and normalization to train the robot model, use reinforcement learning to let a robot learn from simulations, and build many types of deep learning systems.

2. Course Modules with quantitative lecture hours:

Introduction to Deep Learning for Robotics: Supervised learning for robotics applications, Backpropagation to train neural networks, Overfitting, and Neural network architecture for several robot functions. **(6 hours)**

Neural networks for robot motion control: Neural networks for inverse kinematic motion calculation, Training with techniques such as dropout and regularization, Solving high-dimensional problems by dimension reduction with principal component analysis (PCA). **(10 hours)**

Reinforcement Learning: Write a reinforcement learning agent with PyTorch, Overview of Reinforcement Learning Coach - a state-of-the-art reinforcement learning framework. **(10 hours)**

Temporal data and neural networks: Backpropagation through time and vanishing or exploding gradients, Variations of recurrent neural networks (RNN), and LSTMs to implement them in PyTorch. **(10 hours)**

Laboratory/practical/tutorial Modules:

Neural networks for robot motion control, Reinforcement Learning, Temporal data and neural networks. **(6 hours)**

3. Textbooks:

1. Iosifidis A. and Tefas A., *Deep Learning for Robot Perception and Cognition*, Elsevier.
2. Arana-Daniel N., Alanis A. Y., Lopez-Franco C., *Neural Networks for Robotics: An Engineering Perspective*, CRC Press.
3. Nath V. and Levinson S. E., *Autonomous Robotics and Deep Learning*, Springer.

4. References:

1. Sutton R. and Barto A., *Reinforcement Learning: An Introduction*, MIT Press.
2. Russell S. and Norvig P., *Artificial Intelligence: A Modern Approach*, Prentice Hall.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR510
Course Name : Underactuated Robotics
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion : None

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1. Preamble:

Robots today move far too conservatively, using control systems that attempt to maintain full control authority at all times. Humans and animals move much more aggressively by routinely executing motions that involve a loss of instantaneous control authority. Controlling nonlinear systems without complete control authority requires methods that can reason about and exploit the natural dynamics of our machines. This course introduces nonlinear dynamics and control of underactuated mechanical systems, with an emphasis on computational methods. Topics include the nonlinear dynamics of robotic manipulators, applied optimal and robust control, and motion planning. Discussions include examples from biology and applications to legged locomotion, compliant manipulation, underwater robots, and flying machines.

2. Course Modules with quantitative lecture hours:

Introduction to Underactuated Robotics: Motivation, Fully-actuated vs Underactuated systems, Feedback equivalence, Input and State constraints. **(6 hours)**

Robot dynamics and model-based control: Nonlinear dynamics with a constant torque, Acrobots, Cart-poles, and Quadrotors. **(6 hours)**

Dynamic programming: Lyapunov analysis; Trajectory optimization, Trajectory stabilization; Policy search; Multibody parameter estimation, Formulating control design as an optimization. **(6 hours)**

Simple models of walking and running: Limit cycles, Simple models of walking such as Rimless wheel, Compass gait, Kneed walker, Curved feet, Simple models of running such as Spring-loaded inverted pendulum (SLIP), Hopping robots, Toward human-like running. **(8 hours)**

Planning and control through contact: Sampling-based motion planning, Complete motion planning, Feedback motion planning, Planning as Combinatorial + Continuous Optimization. **(8 hours)**

Stochastic dynamics: Stochastic/ robust control, Master equation, Stationary distribution, Costs and constraints for stochastic systems, Finite Markov Decision Processes, From linear models to deep models. **(8 hours)**

3. Textbooks:

1. Tedrake R., Underactuated Robotics: Algorithms for Walking, Running, Swimming, Flying, and Manipulation, MIT Press.

4. References:

1. Xin X. and Liu Y., Control Design and Analysis for Underactuated Robotic Systems, Springer.
2. Birglen L., Laliberte T., and Gosselin C., Underactuated Robotic Hands, Springer.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR511
Course Name : Autonomous Mobile Robots
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

Students will be introduced to the main topics in the theoretical and practical design of mobile robots. Mobile robots enable humans to explore unexplored territories ranging from space to the deep sea, and extreme environments. Recent developments of autonomous transportation in the industry and mobile robots for defense applications have implemented various fields of engineering ranging from design, fabrication, motion planning, navigation, guidance, and control of intelligent mobile robot systems. This course focuses on both computational and practical aspects to give students an opportunity to design, develop and control mobile robots based on the learned theoretical concepts.

2. Course Modules with quantitative lecture hours:

Robot locomotion: Types of locomotion using hopping, leg, wheel. Types of mobile robots: ground robots (wheeled and legged robots), aerial robots, underwater robots, and water surface robots. Discussion on stability, maneuverability, and controllability. **(4 hours)**

Robot kinematics and dynamics: Forward and inverse kinematics, degree of freedom and maneuverability, holonomic and nonholonomic constraints, kinematic models of wheeled and legged robots, dynamics simulation**,** Classification of models, Rigid body dynamics, Lagrange-Euler and Newton-Euler methods. Computer-based dynamic (numerical) simulation of different robots. **(12 hours)**

Sensors for mobile robot navigation: Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, Doppler effect-based sensors, laser scanner, infrared rangefinder, visual and motion; uncertainty in sensing and filtering. **(6 hours)**

Navigation: Localization, error propagation model, Probabilistic map-based localization, Autonomous map building, Simultaneous localization and mapping (SLAM). **(6 hours)**

Motion and path planning: Line of sight guidance strategies, Collision free path planning, sensor-based obstacle avoidance, and trajectory tracking. Path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, and probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), and stochastic dynamic programming (SDP). **(8 hours)**

Modern mobile robots: Swarm systems, Cooperative and collaborative systems, and autonomous mobile manipulation. **(4 hours)**

Final project: Student project towards design, fabrication, and programming of a mobile robot. **(4 hours)**

3. Textbooks:

1. Siegwart, Roland, Illah Reza Nourbakhsh, and Davide Scaramuzza. Introduction to autonomous mobile robots. MIT press, 2011.

2. Dudek, Gregory, and Michael Jenkin. Computational principles of mobile robotics. Cambridge university press, 2010.
3. Melgar, E. R., Diez, C. C., Arduino and Kinect Projects: Design, Build, Blow Their Minds.

4. References:

1. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics.
2. S. M. LaValle, "Planning Algorithms", Cambridge University Press, 2006. (Online)
3. Thrun, S., Burgard,W., and Fox, D., Probabilistic Robotics. MIT Press, Cambridge, MA.
4. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms and Implementations, PHI Ltd.

Course Number : AR512
Course Name : Rapid Prototyping and Tooling
Credit Distribution : 3-0-2-4
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

Students will be introduced to the main topics in the theoretical and practical aspects of Rapid Prototyping. It involves the study of various processes of Rapid prototyping (RPT) techniques. Students will be introduced to the theoretical principles underlying Rapid tooling and reverse Engineering. Students work in teams to produce the final model for RPT using 3D modelling software.

2. Course Modules with quantitative lecture hours:

Product Development: Manufacturing processes classification, Different manufacturing systems. Introduction, History, Definitions, and evolution of Rapid Prototyping. Need of RPT in context to batch production, FMS, CIM, and its application. Introduction & Need for the compression in Product development Growth of RPT Industry and Classification of RPT. **(6 hours)**

Stereolithography (SLA): System and principles, process parameters, SLA process details, data preparation, data files of SLA, machine details, and applications of SLA. **(4 hours)**

Selective Laser Sintering (SLS): Introduction, SLS operation principle, and machine types, process parameters, and data preparation for SLS. **(4 hours)**

Fused Deposition Modelling (FDM) and Solid Ground curing (SGC): Introduction, FDM principles, process parameters, path generation & application of FDM. Principle of SGC operation, SGC machine details and application. **(6 hours)**

Laminate Object Manufacturing (LOM): Operation principle, materials, process details & application, Concepts modelers – Principle, Thermal Jet Printer, Sander model maker – Explanation, 3-D Printer. **(4 hours)**

Rapid tooling: Indirect rapid tooling, Silicon Rubber tooling, Aluminium filling epoxy tooling, Spray metal tooling, Direct rapid tooling, Quick cast process, copper Polyamide, DMILS – explanation, sand casting tooling, soft tooling & hard tooling. **(6 hours)**

Software for RPT: STL files, Overview of Solid view, software communicator, Internet-based software, Collaboration tools. **(4 hours)**

Other aspects of Rapid Manufacturing: Introduction, factors influencing accuracy, Repetitive masking, and deposition. Beam interference solidification, Holographic interference solidification special topics on RPT using metallic alloys. Programming in RPT modelling, Slicing, Internal Hatching, Surface skin films, and support structure. Data preparation errors, part building errors, errors in finishing, and influence of build orientation. **(6 hours)**

Final project: Student project towards RPT using 3D modelling software. **(2 hours)**

Laboratory/practical/tutorial Modules:

Rapid tooling, Software for RPT

3. Textbooks:

1. Chua. C.K, “Rapid Prototyping”, Wiley.

2. Introduction to Rapid Prototyping, Amitav Ghosh, Northwest Publication, New Delhi.
3. Rapid Prototyping and Engineering Applications, Frank W. Liou, CRC Press.
4. Burns. M, "Automated Fabrication", PHI.
5. Hilton. P.D. et al., "Rapid Tooling", Marcel, Dekker.

4. References:

1. Jacobs P.F, "Stereolithography and other Rapid Prototyping and Manufacturing Technologies", ASME.
2. Beaman. J.J et. al., "Solid freeform fabrication", Kluwer.
3. Pham. D.T and Dimov. S.S, "Rapid Manufacturing; the Technologies and Application of RPT and Rapid tooling", Springer, London.
4. Gibson, I., Rosen, D.W. and Stucker, B., 2014. Additive manufacturing technologies (Vol. 17). New York: Springer.
5. Hopkinson, N., Hague, R. and Dickens, P. eds., 2006. Rapid manufacturing: an industrial revolution for the digital age. John Wiley & Sons.
6. Pham, D. and Dimov, S.S., 2012. Rapid manufacturing: the technologies and applications of rapid prototyping and rapid tooling. Springer Science & Business Media.
7. Kamrani, A.K. and Nasr, E.A., Engineering design and rapid prototyping. Springer Science & Business Media.
8. Gebhardt, A., Understanding additive manufacturing.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR513
Course Name : Unmanned Aerial Systems (UAS)
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion : None

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1. Preamble:

Students will be introduced to agile micro aerial vehicles that are able to operate autonomously in cluttered indoor and outdoor environments. They will gain an introduction to the mechanics of flight and the design of quadrotor flying robots and will be able to develop dynamic models, derive controllers, and synthesize planners for operating in three dimensional environments. The students will be exposed to the challenges of using noisy sensors for localization and maneuvering in complex, three-dimensional environments. Finally, the course will provide insights through seeing real world examples of the possible applications and challenges for the rapidly-growing drone industry.

2. Course Modules with quantitative lecture hours:

Introduction: Historical background of UAS, Current trends in UAS, Introduction to Unmanned Aerial Robotics (UAVs) and quadrotors. **(5 hours)**

Geometry and Mechanics: Frame Rotations, Representations and Coordinate Systems, Kinematics and dynamics of system model, Derivation of Aerodynamic Forces. **(6 hours)**

Perception and State Estimation: Sensors on-board, Inertial sensing, Concepts of Kalman Filtering, Inertial Navigation System design. **(8 hours)**

Flight Control: Planar and three-dimensional dynamic models, Linear controllers for these models, Proportional Integral Derivative control, Linear Quadratic Regulator control, Linear Model Predictive Control. **(8 hours)**

Path Planning: Collision-free Navigation, Structural Inspection Path Planning, Target Follow, Coordinated Motion, Collaborative Aerial Manipulation, Autonomous Exploration. **(7 hours)**

Final project: Student project towards simulation and design of UAS. **(8 hours)**

3. Textbooks:

1. Paul Gerin Fahlstrom, Thomas James Gleason, "Introduction to UAV Systems", Wiley.
2. Reg Austin, "Unmanned Aircraft Systems: UAVS Design, Development and Deployment", Wiley. 3.
3. R. Kurt Barnhart, Douglas M. Marshall, Eric Shappee, "Introduction to Unmanned Aircraft Systems", CRC Press.

4. References:

1. Kenzo Nonami et. al., "Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles", Springer.
2. Kimon P. Valavanis, George J. Vachtsevanos, "Handbook of Unmanned Aerial Vehicles", Springer.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity	Approx. % of Content

			Content	
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR514
Course Name : Vision and Learning Based Control
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

This course provides an exposure to vision and learning based control techniques. The course covers a wide range of related topics. The objective is to impart knowledge related to visual servoing, and robot learning along with various applications. By the end of the course, the student will be able to-

• Understand the role of visual sensors to control different real time systems

• Understand the fundamental components of visual servoing

• Understand the key concept for robot learning by demonstration

• Understand the utility of imitation learning for practical systems

• Utilize visual feedback to control the given system of interest

2. Course Modules with quantitative lecture hours:

Introduction: Overview, motivation, and real-world practical applications. **(1 hours)**

Visual Sensor Model and Calibration: Camera model, Coordinate Frames and Transforms, Intrinsic camera calibration, and extrinsic camera calibration. **(10 hours)**

Visual Servoing: Image Jacobian, Robot Jacobian, Image Based Visual Servoing, Position Based Visual Servoing, Eye-in-hand and Eye-to-hand Configurations, Comparison among different class of visual servoing. **(14 hours)**

Robot Learning: Basic concepts of reinforcement learning, reinforcement learning algorithms. Robot learning by demonstration. **(14 hours)**

Hybrid Method Design: Comparative analysis for various methods. Explore, understand and identify different ways to design a hybrid scheme to control the given system of interest. Case study and course projects. **(3 hours)**

3. Textbooks:

1. Corke, Peter I., and Oussama Khatib. Robotics, vision and control: fundamental algorithms in
MATLAB. Vol. 73. Berlin: Springer, 2011.
2. Vakanski, Aleksandar, and Farrokh Janabi-Sharifi. Robot learning by visual observation. John Wiley & Sons, 2017.

4. References:

1. Ijspeert, Auke Jan, et al. "Dynamical movement primitives: learning attractor models for motor
2. behaviors." Neural computation 25.2 (2013): 328-373.
3. Chaumette, François, and Seth Hutchinson. "Visual servo control. I. Basic approaches." IEEE Robotics & Automation Magazine 13.4 (2006): 82-90.

4. Chaumette, François, and Seth Hutchinson. "Visual servo control. II. Advanced approaches [Tutorial]." IEEE Robotics & Automation Magazine 14.1 (2007): 109-118.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Number : AR515
Course Name : Sensors and State Estimation
Credit Distribution : 3-0-0-3
Intended for : UG, PG and PhD
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

This course provides an overall exposure to sensing technology. The course covers a wide range of related topics. The objective of this course is to impart knowledge on smart sensing technology and its applications. By the end of the course, the student will be able to-

● Select right sensor(s) for a particular application

● Understand the importance of data fusion and state estimation

● Estimate the state of the system of interest using sensor fusion

2. Course Modules with quantitative lecture hours:

Sensors: Introduction and motivation, different types of sensors and their real time applications, signal conditioning, classic vs smart sensors. **(10 hours)**

Recursive State Estimation: Overview, basic concept in probability, robot environment interaction, Bayes filter. **(7 hours)**

Filtering Techniques: Introduction, Kalman Filter (KF), Extended Kalman Filter (EKF), Unscented Kalman Filter (UKF), Particle Filter, and Quantum Stochastic Filtering. **(15 hours)**

Multi-sensor Data Fusion: Introduction to multi-sensor systems, some examples like Unmanned Aircraft System (UAS), reference frame for multi-sensor fusion, calibration, synchronization, multi-sensor fusion with EKF. Case study and course projects. **(10 hours)**

3. Textbooks:

1. Thrun, Sebastian. "Probabilistic robotics" Communications of the ACM 45.3 (2002): 52-57.
2. Fraden, Jacob. "Handbook of modern sensors: physics, designs, and applications" (1998): 357-359.

4. References:

1. Bhuyan, Manabendra. Intelligent Instrumentation: Principles and Applications. CRC Press, 2010.
2. Sawhney, A. K. "Electrical and electronic Measurements and Instrumentation" (1985).
3. Behera, Laxmidhar, and Indrani Kar. "Quantum stochastic filtering" 2005 IEEE International Conference on Systems, Man and Cybernetics. Vol. 3. IEEE, 2005.
4. Meijer, Gerard, ed. Smart sensor systems. John Wiley & Sons, 2008.
5. Jacob Fraden, “Handbook of modern Sensors”, AIP Press, Woodbury (1997).
6. E. O. Deobelin and D. Manik, “Measurement Systems – Application and Design”, Tata McGraw-Hill (2004).
7. Yallup, Kevin, and Krzysztof Iniewski, eds. Technologies for smart sensors and sensor fusion. CRC Press, 2014.
8. Prosser, Stephen J., and Ernest DD Schmidt. "Smart sensors for industrial applications." Sensor Review (1997).

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi - Proposal for a New Course

Course Number : BE306
Course Name : Genetic Engineering: principles and applications
Credit Distribution : 3-1-0-4
Intended for : UG (IDD Bioengg, 3rd year)
Prerequisites : IC136 or consent of the faculty member
Elective or Core : Discipline core
Semester : Odd
Mutual Exclusion : None

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1. Preamble: The main objective of this course is to introduce the concepts, developments, and applications of genetic engineering or recombinant DNA technology (rDNA tech). This course provides a comprehensive understanding of plasmids/vectors, DNA modifying enzymes such as restriction enzymes that cut DNA, ligases that join DNA fragments, and polymerases that amplify DNA fragments. The students will learn how rDNA technology works by exploring various DNA cloning methods. By the end of this course, students will be able to understand the principles of recombinant DNA technology and methods associated with it such as cutting, joining, and amplifying DNA fragments. They will also get hands-on training on gene cloning methods and learn to use online tools to analyze DNA sequences and design primers. As a result of this course, the students will have strong foundations and first-hand scientific understanding and hands-on training in genetic engineering and how it can be used to generate genetically modified organisms for commercial, agricultural, and medical purposes.

2. Course Modules with quantitative lecture hours:

Module-1 Introduction ***[12 hours]***
Gene and mRNA structure and properties; analysis of DNA and RNA sequences, DNA and RNA modifying enzymes (Restriction Enzymes, DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase). Introduction to genetic engineering and GMOs.

Module-2 PCR and Its Applications ***[11 hours]***
Primer, Primer designing, Thermostable DNA polymerases, PCR, Types of PCR – multiplex, nested, reverse transcriptase, cDNA synthesis, real-time PCR, touchdown PCR, hot start PCR, colony PCR. Site-directed mutagenesis, Mutation detection, PCR in molecular diagnostics, Viral and bacterial detection.

Module-3 Cloning Vectors ***[8 hours]***
Bacterial and viral based plasmids (PUC19, Bluescript vectors, M13 vectors, SV-40 vectors, Phagemids, Cosmids); Artificial chromosome vectors (YACs; BACs); Plant based vectors, Ti and Ri as vectors, Selection of vectors, Expression vectors (pMal; GST; pET-based vectors)

Module-4 Cloning Methodologies ***[12 hours]***

Restriction Enzyme Based Cloning; PCR Cloning (TOPO or TA); Ligation Independent Cloning (LIC); Seamless Cloning (SC); Recombinational Cloning; Gibson Assembly (Isothermal Assembly Reaction); Expression cloning, Construction of genomic and cDNA libraries.

Module-5 Introduction of DNA into cells ***[7 hours]***

Introduction of DNA into bacterial cells (transformation methods), viruses (transduction methods), mammalian cells (Transfection techniques), plant tissues (Transfection techniques, particle bombardment), and model organisms (microinjections).

Module-6 Genetic engineering applications, case studies and ethical issues [6 hours]

Recent developments in genetic engineering methods; Applications of genetic engineering in agriculture and medicine; GMOs and GEMs; Socio-economic, cultural, and ethical issues.

3. Textbooks:

1. Terry A. Brown, Gene Cloning: An Introduction. 8th edition, Wiley-Blackwell, 2021; ISBN 978-1119640783.
2. Sandy B. Primrose, Richard Twyman, Principles of Gene Manipulation and Genomics. 8th edition, John Wiley Blackwell, 2016; ISBN 978-8126548392.

4. References:

1. Michael R. Green and J. Sambrook. Molecular Cloning: A Laboratory Manual (Fourth Edition), Vols 1-3, Cold Spring Harbor Laboratory Press, CSHL, 2012; ISBN 1936113422.
2. B. Alberts, R. Heald, A. Johnson, D. Morgan, M. Raff. Molecular Biology of the Cell, 7th edition, W.W. Norton & Co Inc, 2022; ISBN 978-0393884821

- Relevant research articles/reviews will be advised relating to the topic being taught.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	BE202	PCR lab	5%

6. Justification of new course proposal if cumulative similarity content is >30%:

None

Approvals:

Other Faculty interested in teaching this course:

Proposed by: Dr. Prasad Kasturi **School:** SBB

Signature: **Date:** **07.03.2023**

Recommended/Not Recommended, with Comments:

_____ Date:_____

Chairperson, CPC

Approved / Not Approved

_____ Date:_____

Chairperson, BoA

IIT Mandi Proposal for a New Course

Course number : **BE307P**
Course Name : **Reverse Engineering for Bioengineers**
Credit Distribution : ***0-0-2-1***
Intended for : B.Tech.-M.Tech. Integrated Dual Degree in Bioengineering (Core Course)
Prerequisite : No prerequisite (compulsory for Bioengineering students)
Mutual Exclusion : NA

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1. Preamble:

The course is designed to introduce the students to:

- Understanding of basic biomedical engineering systems.
- Understand the terminologies related to re-engineering, forward engineering, and reverse engineering.
- Disassemble products and specify the interactions between its subsystems and their functionality
- Understand Reverse Engineering methodologies.
- Understand Reverse engineering of Biotechnological/ Biomedical devices.

Course Modules (28 total hours):

The students focus on hardware reverse engineering (RE). In the process of RE students understand existing technologies, functions, features, objects, components and systems. By carefully disassembling, observing, testing, analyzing and reporting, students can understand how something works and suggest ways it might be improved. This process requires careful observation, disassembly, documentation, analysis and reporting. Many times, the reverse engineering process is non-destructive. This means that the object or component can be reassembled and still function just as it did before it was taken apart. Throughout the reverse engineering project, the students are able to think of ways these objects could be improved. Is there some way it could function better? or manufactured less expensively? The students will use observations to make suggestions for improvement of the product.

Learning Topics: Reverse Engineering of Biotechnological/Biomedical- Devices/ prototypes.

2. Text books:

1. Lam, R.H. and Chen, W., 2019. Biomedical Devices. Materials, Design, and Manufacturing. Springer, Reading, Massachusetts, 1.
2. Boccato C, Cerutti S, Vienken J, editors. Medical devices: improving health care

through a multidisciplinary approach [Internet]. Cham: Springer International Publishing; 2022

3. References:

1. **RE as necessary phase by rapid product development by Sokovic and Kopac. Journal of Materials Processing Technology 2005**
2. **Reversing: Secrets of Reverse Engineering by Eldad Eilam Publisher: Wiley (April 15, 2005)**
3. **The IDA Pro Book: The Unofficial Guide to the World's Most Popular Disassembler by Chris Eagle**

4. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.	Course Name	Course Code	Similarity Content	Approx. % of Content
1.	NA			
2.				

6. Justification of new course proposal if cumulative similarity content is >30%: NA

Approvals:

Other Faculty interested in teaching this course: –

NA

Proposed by: Dr. Sumit Murab **School: SBS**

Signature: **Date: 20-03-23**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi Proposal for a New Course

Course number : **BE308**
Course Name : **Introduction to Biomanufacturing**
Credit Distribution : ***3-0-2-4***
Intended for : B.Tech.-M.Tech. Integrated Dual Degree in Bio-Engineering
Prerequisite : IC 136 Understanding Biotechnology and its Applications
or Consent of Faculty Member
Mutual Exclusion : NA

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1. Preamble:

The course is designed to introduce **Principles of Biomanufacturing** including the biological, material and engineering aspects. The course will provide a thorough understanding of biomanufacturing concepts, design, good manufacturing practices and translation for both biologicals and tissue engineered/ 3D printed/ 3D Bio-printed products. The course will also focus on the regulatory and process development aspects of the biomanufacturing process.

Course Modules with quantitative lecture hours (42 total hours):

Module 1: Manufacturing of Biomolecules (12 Hours)

Introduction to Biologicals, Biomolecules for industrial application, Stages of biomanufacturing, Case studies, Expression systems, Nutritional strategies/cell culture media, Cell growth, Bioreactor design, operation, and control,

Module 2: Production, Isolation & Purification (12 Hours)

Cell separation: centrifugation and depth filtration, Chromatography, Viral clearance, Ultrafiltration and diafiltration, Bulk filling

Module 3: Industrial Scaleup (12 Hours)

Applicable Regulations and Guidelines, GMP and GDP. Clinical evaluation, Registration or licensing, Quality assessment, Stages of Process Development- early, mid, late, Process characterization, Process validation, Scale-up considerations

Module 4: Policies & Future Directions in Biomanufacturing (6 Hours)

Bench to bedside concept, Development of new stem-cell- based therapies, tissue engineered,

3D-Bioprinted tissues/ organs, Preclinical studies for first-in-human studies, Discovery process in cell and gene therapy/ tissue engineering, First-in-humans studies, Phase 1 first-in-human studies, target product profile (TPP), Human subject ethical issues.

Laboratory Experiments (28 Hours):

1. Alginate bead encapsulation
2. Chromatography
3. Ultrafiltration and diafiltration
4. Cell separation

2. Text books:

1. **Gilleskie, Gary, Charles Rutter, and Becky McCuen. Biopharmaceutical Manufacturing: Principles, Processes, and Practices. Walter de Gruyter GmbH & Co KG, 2021.**
2. **Atala, Anthony, and Julie Allickson, eds. Translational regenerative medicine. Academic Press, 2014.**
3. **Biological Drug Products: Development and Strategies; Wei Wang , Manmohan Singh ; Wiley,2013**

3. References:

1. **Online Textbook: https://biomanufacturing.org/curriculum-resources/textbooks-manuals/introduction-to-biomanufacturing**
2. **Related journal article**

4. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	Tissue Engineering	BE507	Development of tissue engineered products	2%
2.	Enzymology and Bioprocessing	BE 203	Bioreactor operation	3%

6. Justification of new course proposal if cumulative similarity content is >30%: NA
Approvals:

Other Faculty interested in teaching this course: – NA

Proposed by: Dr. Sumit Murab **School: SBS**

Signature:  **Date: 20-03-23**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____
Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____
Chairperson, BoA

IIT Mandi Proposal for a New Course

Course number : **BE401**
Course Name : **Bioengineering Mini Project, Term Paper and Seminar**
Credit Distribution : ***0-0-8-4***
Intended for : B.Tech.-M.Tech. Integrated Dual Degree in Bio-Engineering
Prerequisite : NA
Mutual Exclusion : NA

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1. Preamble:

The course is designed to introduce **B.Tech. Bioengineering** Mini project which also include term paper and seminar. The students will be allocated to the SBB and other institute faculties interested in floating a mini-project. Two students will be allocated for each project, who will work together.

The term paper will be allocated by the faculty supervisor to the students and the seminar presentation will be based on the mini-project.

Course Modules with quantitative lecture hours:

Mini-Project: This will be floated by the faculties and then students in a group of two will be allocated for the floated projects.

Term Paper: Term paper will be a detailed research focused assignment on a scientific topic. The term paper submitted by the students will be decided by the faculty supervisor.

Seminar: The students will give one seminar on a published research paper relevant to their mini-project.

Laboratory/practical/tutorial Modules: NA

2. Text books:

NA

3. References:

NA

4. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

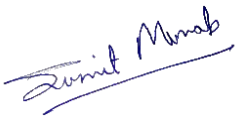
NA

6. Justification of new course proposal if cumulative similarity content is >30%: NA
Approvals:

Other Faculty interested in teaching this course: –

NA

Proposed by: Dr. Sumit Murab **School: SBB**

Signature:  **Date: 18-12-22**

Recommended/Not Recommended, with Comments:

_____ **Date:_____**
Chairperson, CPC

Approved / Not Approved

_____ **Date:_____**
Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number	**: BE 507**
Course Name	**: Tissue Engineering**
Credit Distribution	**: 3-0-0-3**
Intended for	**:** B.Tech.-M.Tech. Integrated Dual Degree in Bio-Engineering, M. Tech Biotechnology and PhD candidates
Prerequisite	**:** IC 136 Understanding Biotechnology and its Applications or IC 241 Materials Science for Engineers or Consent of Faculty Member
Mutual Exclusion	**:** NA

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1. Preamble:

The course is designed to introduce **principles of tissue engineering** including the biological, material and engineering aspects. The course will provide a thorough understanding of tissue regeneration using material platforms, their interactions with the surrounding tissue and immune system. The dynamics of cell-extracellular matrix interaction and its effect on tissue regeneration will be covered. The applications of these principles in developing 3D printed/ bioprinted tissues and organs, as well as in vitro disease models that are the forefronts of biomedicine; will be discussed.

2. Course Modules with quantitative lecture hours:

Unit 1: Introduction to Tissue Engineering-The history and scope of tissue engineering, Challenge in imitating nature, Cells as building blocks, Clinical translation

(4 Hours)

Unit 2: Cellular differentiation and Tissue Development -Molecular organization in cells, Cell-matrix interactions, Tissue development

(4 Hours)

Unit 3: Functional Tissue Engineering-Matrix as growth factor reservoir, Mechanobiology of matrix, Biosimilar materials as scaffolds

(6 Hours)

Unit 4: **3D Tissue Culture Techniques-**Animal cell culture, Biomaterials in tissue engineering, Cell interactions with polymers, conventional 3D scaffolds, 3D printing, 3D bioprinting

(8 Hours)

Unit 5: **Transplantation of Engineered Tissues & Disease Models** -Host Immune Response, Immunomodulation, Disease models, applications of disease models

(6 Hours)

Unit 6: Orthopaedic Tissue Engineering -Mesenchymal stem cells, Bone ultrastructure and anatomy, Bone tissue engineering, Articular cartilage tissue engineering, Intervertebral disc tissue engineering, Orthopaedic disease models

(8 Hours)

Unit 7: ***Ophthalmic Tissue Engineering***-Stem cells in the eye, Corneal replacements, Ophthalmic disease models

(6 Hours)

Laboratory/practical/tutorial Modules: NA

3. Text books:

1. **Robert Lanza, Robert Langer and Joseph Vacanti, Principles of Tissue Engineering, Academic press, USA, 2020**
2. **Bikramjit Basu, Biomaterials Science and Tissue Engineering: Principles and Methods, Cambridge University Press, UK, 2017**

4. References:

1. **Bikramjit Basu, Biomaterials for Musculoskeletal regeneration: Concepts, Springer Nature, Switzerland, 2017**
2. **Ravi Birla, Introduction to tissue engineering: applications and challenges. John Wiley & Sons, USA, 2014.**

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	Biomaterials	BE504	Biomaterials for tissue engineering, Interactions, Immune response	10%

6. Justification of new course proposal if cumulative similarity content is >30%: NA

Approvals:

Other Faculty interested in teaching this course: –

Dr Amit Jaiswal (SBS)

Proposed by: Dr Sumit Murab **School: SBS**

Signature: **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Course Name: Practical OMICs

Course Number: BY509

Credit: 0.5-0.5-2-3

Prerequisites: Any MS/MSc/PhD students/BTech students with IC 136 course (Understanding Biotechnology & its Applications) or Consent of Faculty member.

Students intended for: B. Tech. 3rd and 4th year, MS/M.Sc/M.Tech., Ph.D.

Elective or Compulsory: Elective

Semester: Odd/Even

Course Objective:

Genome sequences are now available that enables us to determine the biological components that make up a cell or an organism. These biological components are studied under the fields of OMICS. The recently developed discipline of systems biology examines how these components interact and form networks and how the networks generate whole cell functions corresponding to observable phenotypes. The objective of this course is to first introduce the practical aspects of one or more of the different OMICS methods including Genomics, Transcriptomics, Metagenomics, and others based on the available resources.

Module 1 (10 hours)
Theory and Tutorials:
The theoretical aspects of different OMICs methods will be covered. This will include introduction to best experimental practices of experiment designing, sample selection, metadata selection, sample and library preparation for respective OMICs analysis. This will be followed by downstream analysis of OMICs data obtained including read preprocessing, and the respective analysis of OMICs data.

Module 2 (32 hours)
Practicals:
Mini projects will be assigned to the student involving one or more OMICs experiments. Experimental protocols will be taught and performed utilising the knowledge gained in Module 1 above on assigned case studies. This will be followed by analysis of the data obtained including hands-on exposure of the state-of-the-art software for respective OMICs data analysis, various available resources, and statistical data analysis for the same.

IIT Mandi
Proposal for a New Course

Course number : **CE515**
Course Name : **Environmental Impact Assessment**
Credit Distribution : *3-0-0-3*
Intended for : **UG elective (3rd and 4th Year)/PG elective (M-Tech/PhD)**
Prerequisite : **NA**
Mutual Exclusion : None

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1. Preamble:

The objective of this course will be to provide knowledge of current environmental, social and economic impacts and methods relating to Environmental Impact Assessment (EIA), and consider in detail how these impacts can be quantified and analysed. EIA is a tool used to assess the positive and negative impacts of a project. This tool helps in predicting environmental impacts of a project in the pre-planning stage itself so that decisions can be taken to reduce the adverse impacts. This course will have following learning outcomes

- In this course students will develop basic understanding to assess the impact of project on the environment. Students will also learn criteria for selecting method for impact assessment, parameters for public participation and technique for writing EIA reports.
- Knowledge of EIA processes and stages and how it can be applied to specific areas of mining, thermal power plants, river valley, infrastructure (road, highway, ports, harbours and airports), soil, ecology and climate change, pollution problems.
- The course also provides an opportunity to review and appraise the EIA process and associated techniques through investigation of an EIA case study.

2. Course Modules with quantitative lecture hours:

Module 1-EIA Introduction

Introduction, definitions and concepts, rationale and historical development of EIA, Evolution of EIA; EIA at project; Regional and policy levels; EIA process in India and other countries — **4 hours**

Module 2: EIA Procedure

Initial environmental examination, environmental impact statement, environmental appraisal, environmental impact factors and areas of consideration, Screening and scoping criteria; Rapid and Comprehensive EIA; Environmental health impact assessment; Baseline collection of data; EIA pertinent environmental factors	**8 hours**

Module 3: EIA Methodologies

Generic steps, descriptive checklists, simple interaction matrix, stepped matrix, Networks, Overlays, uniqueness ratio, habitat evaluation system, EIA models	**12 hours**

Module 4: Impact Identification, Management and Reporting

Impact Identification, Analysis & Prediction, Development of environment management plan; Post project monitoring ; Stakeholders consultation / Public Involvement in EIA, Mitigation, elements of mitigation, structure and element of EIA report, EIA documentation, Review process, EIA Regulations in India, Environmental Management: Preventive policy of environment, waste minimisation, conservation of water and energy, use of renewable, sources, pollution audit, pollution control strategy	**10 hours**

Module 5 : Case studies

Principles, problems and strategies and remedial actions, Applications for industrial; Water resources and irrigation projects; ports and harbours, Mining, Transportation and other projects sectors, Prediction & Assessment of Impacts on the Water Environment, Air Environment and Soil Environment	**8 hours**

Laboratory/practical/tutorial Modules: NA

3. Text books:

1. Canter, L. W. Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997.
2. Glasson J., Therivel Riki, Chadwick Andrew, Introduction to Environmental Impact Assessment, Oxford Brookes University 2012/ 4th edition

4. References:

1. Judith,P. and Eduljee,G. Environmental Impact Assessment for Waste Treatment and Disposal Facilities, John Wiley & Sons, 1994.
2. Burke,G., Singh, B.R., and Theodore, L. Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000.
3. Eccleston, C.H.Environment Impact Statements: A Comprehensive Guide to Project and Strategic Planning, John Wiley & Sons, 2000.
4. Shrivastava A.K., Baxter Nicola, Grimm Jacob, "Environmental Impact Assessment", APH Publishers, 2003
5. Anjaneyulu Y., Manickam Valli, "Environmental Impact Assessment Methodologies", CRC Press 2011
6. Welford,R. Corporate Environmental Management - Systems and Strategies, Universities Press, 1996.
7. Whitelaw,K. and Butterworth, ISO 14001: Environmental System Handbook, 1997

4. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	NA			

6. Justification of new course proposal if cumulative similarity content is >30%:

NA

Approvals:

Other Faculty interested in teaching this course: – Dr. Sayantan Sarkar

Proposed by: Dr. Tanushree Parsai **School: SE**

Signature: **Date: 25-03-2022**

IIT Mandi
Proposal for a New Course

Course number	**:**	CE516
Course Name	**:**	Uncertainty Analysis in Civil Engineering
Credit Distribution	**:**	3-0-0-3
Intended for	**:**	B.Tech. 4th year/ M.S./ M.Tech./ Ph.D.
Prerequisite	**:**	Students are suggested to have a background on basic Engineering Mathematics related course at the UG level and the design and testing aspects in Civil Engineering (CE351: Design of Reinforced Concrete Structures or, CE402: Geotechnical Engineering II, or CE401: Design of Steel Structures or, CE354P: Building and Pavement Materials Laboratory, or equivalent)
Mutual Exclusion	**:**	'None'

Preamble:
Nothing in nature is definite but still one can find lot of predictions on strength of material, weather, soil property etc. How this is possible? This course gives you the background on answering such quantification which involves so many uncertainties. Thus, by pursuing this course the students will be equipped to find meaning from random data encountered in civil engineering. The course will deal in detail the qualitative and quantitative analysis on the data (strength parameters, material behavior curve, design loads, design procedures and data like earthquake etc.). The course also gives and exposure on to how possible this information can be further implemented to study a possible response. An effort will also be made to equip students to practically deal with such problems using examples involving computation. After this course, they would be well equipped to understand and develop probabilistic and reliability-based models for suitable design purpose.

1. Course Modules with quantitative lecture hours:

Module 1: The concept of 'Risk and uncertainty' in Civil Engineering (3 Hours)
Difference between deterministic and uncertain parameters, sources of uncertainties in civil engineering, classification and nomenclature of uncertainties (epistemic, aleatory, parametric, etc.), the concept of hazard, vulnerability and risk, Factor of Safety, lower and upper bounds.

Module 2: Uncertainty Quantification in Civil Engineering (10 Hours)
Understanding the examples of discrete and continuous random variables in civil engineering such as soil data, concrete strength data, other strength and design data, uncertainty quantification of such variables in form of mean, variance, COV, histograms, percentiles, box plots, correlation, skewness, scatter, probability distributions (PDF and PMF), expectations, moments, joint probability distributions, and extreme value theories.

Module 3: Introduction to Random Process (7 Hours)
Introduction to earthquake ground motions as random processes, and their basic statistical, temporal, and Spatial characterization including variograms, autocorrelation functions,

probability density, Interpolation methods (e.g., kriging), stationarity, ergodicity, and return period.

Module 4: Uncertainty Simulation & Propagation (**12 Hours**)
Simulating the random variables using the Monte-Carlo approach, Bootstrap method, example case-studies to understand the implications of these random input variables on the desired outcomes (e.g., structural response to random loads, case-studies from construction planning and management), derivation of the probability distributions of output variables, testing their goodness-fit, sensitivity analysis, first order second moment (FOSM) methods, and event tree analysis.

Module 5: Data interpretation and modelling **(6 Hours)**
Introduction to typical data from civil engineering experiments that needs to be modeled, identification of dependent and independent variables through example problems, Correlation analysis between the parameters in the model, identifying outliers, Functional form identification (Parametric, non-parametric), Performance evaluation, confidence interval, a brief overview on approaches to handling of missing information, Mixed-effects regression its significance and application.

Module 6: Advanced and Miscellaneous Topics **(4 Hours)**
The basics concepts of load, resistance, failure probability, factor of safety, and reliability, point estimate method, error propagation, Hasofer-Lind approach, Conditional probability, Bayes' law, Posterior distribution.

Laboratory/practical/tutorial Modules: N.A.

2. Text books:

1. H-S.Ang & W.H. Tang, Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering, Wiley, 2006.
2. Benjamin, Jack R., and C. Allin Cornell. Probability, statistics, and decision for civil engineers. Courier Corporation, 2014.

3. References:

1. Papoulis, A., Probability, Random Variables and Stochastic Processes, 3rd Ed., McGraw-Hill, 1991.
2. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Brooke & Cole, 2009.
3. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers, John Wiley & Sons, 2007.
4. Fellin, W., Lessmann, H., Oberguggenberger, M., & Vieider, R. (Eds.). (2005). Analyzing uncertainty in civil engineering (pp. 51-72). Berlin: Springer.
5. Ross, S. M. (2004). Introduction to probability and statistics for engineers and scientists. Elsevier.
6. Soong, T. T. (2004). Fundamentals of probability and statistics for engineers. John Wiley & Sons.

7. Gordon A. Fenton, & Griffiths, V. D. (2008). Risk assessment in geotechnical engineering (pp. 381-399). New Jersey: John Wiley & Sons.
8. Crandall, S. H., & Mark, W. D. (2014). Random vibration in mechanical systems. Academic Press.
9. Oliver, M. A., & Webster, R. (2015). *Basic steps in geostatistics: the variogram and kriging* (pp. 15-42). Cham, Switzerland: Springer International Publishing.
10. Baecher, G. B., & Christian, J. T. (2005). Reliability and statistics in geotechnical engineering. John Wiley & Sons.

4. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. N.	Course	Course Code	Similarity Content	Approximate % of Content
1	Introduction to Probability	CS511	Definitions on probability, random vector and random process	9% (about 4 lecture hours of this course) *
2	Probability and Random Processes	EE534	Definitions on probability, random vector and random process	9% (about 4 lecture hours of this course)*
3	Statistical Data Analysis	MA605	Description on Statistical tests, and Goodness of fit	7% (about 3 lecture hours of this course)
4	Probability & Statistics	MA524	Basic definition of probability and statistics	9% (about 4 lecture hours of this course)*
5	Statistical Methods	HS550	Concept of moments, Basic definition of probability, Basic concept of Regression	12% (about 5 lecture hours of this course)*

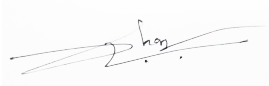
* There is mutual overlap between these courses hence the percentage mentions have intercepts and not mutually exclusive.

6. Justification of new course proposal if cumulative similarity content is >30%:
None of the existing courses on probability and statistics talk about the specific civil engineering applications. In view of this, there is an urgent need of such a course for civil engineering UG and PG students.

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Dr. Shashank Pathak and Dr. Dhanya J.
School: School of Civil & Environmental Engineering (SCENE)

Signature:  **Date:** 29/08/2022

IIT Mandi
Proposal for a New Course

Course number : CE517
Course Name : Hydroinformatics
Credit Distribution : 3-1-0-4
Intended for : B.Tech. (4th year), PG and Ph.D. students
Prerequisite : None; however, familiarity with any computer programming language (e.g., Python, R, MATLAB, etc.) will be helpful during the course.
Mutual Exclusion : None

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1. Preamble:

Hydroinformatics is a newly evolving interdisciplinary subject that utilizes techniques developed in information technology for hydrological applications. With the increasing quantity of large datasets, such as remote-sensing imagery and data from hydro-meteorological simulations, it has become important to derive useful information from these datasets for efficient decision-making. However, traditional spreadsheet-based analysis tools can hardly be used to generate useful information from such large datasets. In this course, students will learn to utilize programming-based advanced hydroinformatics techniques for analyzing climate data, hydrometeorological data, and geospatial data. Students will also get an opportunity to learn to develop automatic calibration tools based on multiobjective optimization for hydrological modeling.

2. Course Modules with quantitative lecture hours:

Module I: Introduction: 6 Hours
Introduction to Hydroinformatics, hydrology, water resources, Smart water management; Forecasting and Early warning system; Major sources of meteorological, climatic, and hydrologic data

Module II: Databases and Data Models 8 Hours
Data life cycle, Data structures, Database management, Data Storage and retrieval, and use data from data models; CSV; NetCDF; Big Data; query aggregate and pivot data using Structured Query language (SQL), Entity Relationship Model; Introduction to Programming and computational tools Python, R, excel, etc.

Module III: Data Analysis and Visualization 8 Hours
Exploratory data analysis techniques; Introduction to data visualization tools; Basic and Specialized Visualization Tools; Visualization tools for geospatial data; interactive data visualization; Creating data dashboards

Module IV: Geospatial Analysis 8 Hours

Analysis of vector and raster datasets; Map Scale and projections; Introduction to GDAL; raster and vector conversions; Analysis and visualization of DEM; Watershed analysis and characterization; Watershed assessment and susceptibility/ vulnerability mapping; Raster querying; Stack Mosaic; Introduction to WebGIS, Introduction to Google Earth Engine and Microsoft Planetary Computer

Module V: Modelling and Simulations 12 Hours

Time series analysis, Rainfall-runoff modeling; statistical analysis: Regression, probability distributions, interpolation, autocorrelation, hypothesis testing, frequency analysis, and return period estimation; Missing data; Hydrological modeling: Uncertainty and sensitivity analysis; Calibration and validation using Monte Carlo (MC), Markov Chain Monte-Carlo (MCMC), Maximum likelihood estimation (MLE), Shuffled Complex Evolution Algorithm (SCE-UA), Dynamically Dimensioned Search algorithm (DDS); Machine learning techniques in Hydrology

3. Text books:

1. Kumar, P., Folk, M., Markus, M., & Alameda, J. C. (2005). Hydroinformatics: data integrative approaches in computation, analysis, and modeling. CRC Press.
2. Remesan R., Mathew J. (2015). Hydrological Data Driven Modelling: A Case Study Approach. Springer.

4. References:

1. Tomer, S. K. (2011). Python in Hydrology. Green Tea Press.
2. Beven, K. J. (2011). Rainfall-runoff modelling: the primer. John Wiley & Sons.
3. Lee, T., Singh, V. P., & Cho, K. H. (2021). Deep Learning for Hydrometeorology and Environmental Science. Springer.

Note: Some research papers, reports and handouts will also be provided as study material during the class.

4. **Similarity with the existing courses:**
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.	Course Code	Similarity Content	Approx. % of Content
1	CE 601	10	25%

6. Justification of new course proposal if cumulative similarity content is >30%:
Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Dr. Vivek Gupta
School: School of Civil and Environmental Engineering

Signature:  **Date:** 13-11-2022

IIT Mandi

Proposal for a New Course

Course number : **CE518**
Course Name : **Structural Reliability and Risk Assessment**
Credit Distribution : ***3-0-0-3***
Intended for : **UG/PG elective**
Prerequisite : **CE 351 – Design of Reinforced Concrete Structures**
Mutual Exclusion : **None**

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1. Preamble:

Uncertainty is ubiquitous in all sorts of modelling and experimental processes in science and engineering. The objective of this course is to develop an understanding of the reliability analysis of structural systems having uncertainty and exposed to random environment. The course will introduce the probabilistic bases of structural reliability, the techniques and methods of evaluating the reliability of structural components and systems, the methodology in the development of reliability-based design criteria and lifetime risk assessment of structures (buildings and bridges) under service loads and natural hazards. The course will help the students to develop their skills to take this subject for further research.

2. Course Modules with quantitative lecture hours:

Module 1: Review of Probability and Statistics - Basic definition of probability, Concept of random variables; Concepts of probability functions - PDF, CDF, and PMF; Types of probability distributions; Correlations, Conditional probability, Bayes theorem **[8 hours]**

Module 2: Structural Reliability Analysis 1 - Basic concepts, Exact solution, Mean value first-order second-moment (MVFOSM), First-order second-moment (FOSM), First-order reliability method (FORM), Sensitivity analysis. **[8 hours]**

Module 3: Probabilistic Simulations - Monte Carlo simulations, Stratified sampling, Importance sampling. **[5 hours]**

Module 4: Structural Reliability Analysis 2 – Component and System reliability, Second-Order Reliability Method (SORM), Time-varying reliability, Response surface method, Introduction to machine learning tools. **[8 hours]**

Module 5: Reliability-based design codes – Introduction, LRFD, Calibration of safety

factors. **[6 hours]**

Module 6: Advanced Topics and Applications - Risk assessment of civil structure and infrastructure systems under service loads and natural hazards; Reliability-based Optimization Problems; Bayesian Inference Techniques; Application in structural health monitoring - Concept of Value of Information. **[7 hours]**

3. Text book:

- Nowak, A.S. & Collins K.R., Reliability of Structures, 2nd ed., CRC Press, 2012.
- Ranganathan R, Structural Reliability: Analysis and Design, Jaico Publishing, 2006.

4. References:

- Melchers RE, Structural Reliability Analysis and Prediction, 2nd ed., Wiley, 1999.
- Haldar, A & Mahadevan, S, Probability, Reliability, and Statistical Methods in Engineering Design, Wiley, 1999.
- Wang, C. Structural Reliability and Time-dependent Reliability. Cham, Switzerland: Springer, 2021.
- Ditlevsen, O., & Madsen, H. O., Structural Reliability Methods (Vol. 178). New York: Wiley, 1996.
- Chandrasekaran, S, Reliability and Risk Assessment, CRC Press, 2016
- Thoft-Christensen, P. , & Murotsu, Y., Application of Structural Systems Reliability Theory, Springer Verlag, 1986.

5. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S.No	Course Code	Similarity Content	Approx. % of Content
1	CE555 – Advanced Design of Structures	Probability distributions and modeling for loading and material strength; Reliability of Structures	< 5%
2	MA 524- Probability and Statistics	Probability distributions and statistics basics	< 5%

6. Justification of new course proposal if cumulative similarity content is >30%:

NA

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Dr. Shivang Shekhar **School: SCENE**

Signature: **Date: 25/08/2022 (Revised on 04/01/2023)**

Course Name	: Chemistry of Natural Waters
Course No.	: CE 519
Pre-requisites	: Environmental Science, Chemistry
Intended for	: UG/M.Tech./MS/PhD
Proposed by	: Harshad V. Kulkarni, Ph.D.
Disciplines	: Civil and Environmental Engineering, Basic Sciences (Chemistry)

Course Description

The overall objective of this course is to understand the fundamental (primarily thermodynamic) controls on the composition of natural waters and the response of natural waters to variations in various physico-chemical parameters. Additionally, this course will explore applications to environmental problems like contaminants migration in waters (groundwaters, surface waters), weathering, etc. Students will learn to solve numerical problems related to the behavior of components in natural waters and gain familiarity with simple analytical techniques for the characterization of natural waters. Examples of topics covered in this course include microbial activity, surface chemistry, redox chemistry, contaminant mobilization, treatment and remediation. This course is designed for undergraduate and graduate students in the fields of civil and environmental engineering, chemistry, biogeochemistry, contaminant hydrology, geomicrobiology.

Course Outline

1. **Hydrologic Cycle (4 hours).** This chapter will focus on various components of hydrologic cycle. The chapter discusses composition of rainwater, fundamentals of hydrology, non-meteoric types of water, and chemical terminologies used in hydrology.
2. **Chemical Thermodynamics (4 hours).** This chapter introduces chemical concepts applied to hydrology, and includes topics like units and terminologies, equilibrium thermodynamics, activity-concentration relationships and diffusion.
3. **Chemical kinetics (4 hours).** This topic discusses one of the important controls on water chemistry. The topics of discussion include mineral nucleation, dissolution and growth, and uses quantitative examples like dissolution of calcite in seawater, dissolution of silicates etc.
4. **Carbonate System and pH Control (4 hours).** This chapter discusses one of the most important systems relevant to water quality. The topics of discussion include carbonic acid system, alkalinity and titration curves, calcium carbonate solubility, dolomite solubility, high-magnesium calcite solubility, ground and surface water in carbonate terrains, carbonate chemistry in oceans, and acid water chemistry.
5. **Organic Compounds in Natural Waters (4 hours).** This chapter focuses on structure of natural organic solutes, functional groups, humic substances, and dissolved organic carbon in natural environments.
6. **Redox Conditions in Natural Waters (4 hours).** This chapter will introduce fundamental ideas such as standard hydrogen electrode and thermodynamic conversions, measurement of Eh, pe-pH and Eh-pH diagrams construction and interpretation, partial pressure or fugacity diagrams and interpretation. This chapter will also discuss processes controlling redox equilibrium in natural water such as photosynthesis, respiration and decay, redox buffering, and use specific case studies of lakes, oceans, and groundwater chemistry to illustrate the concepts.
7. **Ion exchange and Sorption (4 hours).** This topic focuses on an important phenomenon of ion exchange that occurs naturally especially with clay minerals and widely used in environmental engineering applications for water and wastewater treatment. The topics of discussion include mineralogy and composition of ion exchange material, colloid properties, and retardation of

pollutant cations in groundwater. Concepts of adsorption – desorption, adsorption isotherms etc. will be discussed in the context of natural and engineered water chemistry.

8. **Weathering and Water Chemistry (5 hours).** First part of this chapter will focus on fundamental principles such as soil formation, mass balance, thermodynamic, and statistical approaches to study weathering and water chemistry. The second part of this chapter will focus on specific case studies including river and groundwater systems and their evolution in terms of water chemistry due to weathering.
9. **Surface and Groundwater Chemistry (5 hours).** This chapter will overview chemistry of surface waters including rivers, lakes, oceans, role of environmental factors affecting their chemistry, effects of climate change, and combining the ideas learnt earlier to understand and model surface water chemistry. This chapter will also overview chemistry of groundwater in variety of aquifers worldwide and controlling factors. Ideas about the sediment-water interactions will be introduced in this chapter. Various data visualization techniques will be used to interpret groundwater chemistry.
10. **Contaminants in Natural Waters (4 hours).** Many of the trace elements are of human health concern. This chapter will focus on understanding sources of trace elements (metals or metalloids), their speciation (pH and redox dependent), controls on solubility, adsorption and coprecipitation controls important for remediation, and their uptake by organisms important for bioremediation. Other topics such as organic contaminants, emerging contaminants, acid rain and drainage, eutrophication etc. and more will also be discussed in this chapter.

Textbooks / Reference Books

- Drever, J.I., 1988. The geochemistry of natural waters. Englewood Cliffs: Prentice hall.
- Baird, C. and Cann, M., 2012. Environmental Chemistry. W. H. Freeman and Company.
- Masters, G.M., 1996. Introduction to Environmental Engineering and Science. Prentice-Hall, Inc.
- Faure, G., 1991. Principles and Applications of Geochemistry. Prentice-Hall, Inc.
- D. Langmuir. Aqueous Environmental Geochemistry.
- Appelo and Postma. Geochemistry, Groundwater, and Pollution.
- Stummn and Morgan. Aquatic Chemistry.

Disciplines: Civil and Environmental Engineering, Basic Sciences (Chemistry)

IIT Mandi
Proposal for a New Course

Course number : **CE613**
Course Name : **Mechanics of Unsaturated Soils**
Credit Distribution : *3-0-0-3*
Intended for : **UG and PG students**
Prerequisite : **Geotechnical Engineering I (CE302), Geotechnical Engineering II (CE 402) or equivalent course.**
Mutual Exclusion : *None*

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1. Preamble:

The conventional course on Geotechnical Engineering introduces students to the traditional analysis and design procedures which considers the soil as either completely dry or completely saturated. But the significant portion of the conditions encountered in the routine geotechnical engineering practice involves unsaturated soils. Therefore, the major aim of this course is to introduce the students to the fundamental behaviour of unsaturated soils. The course starts with concepts of phases relationships in unsaturated soils, contractile skin, and stress state variables. Then the course discusses in detail about the concepts of soil suction and measurement of soil suction, soil water characteristic curve, permeability in unsaturated soil through laboratory testing. Through this course, the students will also learn about the shear strength properties of unsaturated soils, determination of its shear strength through triaxial and direct shear tests, and estimation of swelling pressure and heave.

2. Course Modules with quantitative lecture hours:

1. Introduction to Unsaturated Soil Mechanics: Role of climatic conditions, Need and application areas of unsaturated soil mechanics, Typical profile of unsaturated soils (**2 Hours)**

2. Phase Properties and Stress state variables: Properties of individual phases, Interaction of air and water, Volume-mass relations, Effective stress for unsaturated soils, Stress state variables, Limiting stress state conditions and experimental testing of stress state variables **(8 Hours)**

3. Measurement of soil suction: Theory of soil suction, Capillarity, Measurement of Total suction, Matric suction, and Osmatic suction **(8 Hours)**

4. Flow behaviour in unsaturated soils: Flow of water, Driving potential for water phase, Darcy's law, coefficient of permeability with respect to water phase, steady state flow **(8**

Hours)

5. Shear strength of unsaturated soils: Failure envelope for unsaturated soils, Triaxial and direct shear tests on unsaturated soils **(8 Hours)**

6. Stress-deformation analysis for unsaturated soils: Swelling pressure determination, 1-D Heave estimation, Foundation design in expansive soil **(6 Hours)**

Laboratory/practical/tutorial Modules: None

3. Textbooks:

1. **Fredlund, D.G., Rahardjo, H., and Fredlund, M.D., "Unsaturated Soil Mechanics in Engineering Practice", 2nd Edition, John Wiley & Sons, Inc., USA, 2012.**
2. **Lu, N., and Likos, W.J., "Unsaturated Soil Mechanics", 1st Edition, John Wiley & Sons, Inc., USA, 2004.**

4. References:

1. **Ng, Charles, W.W., and Menzies, B., "Advanced Unsaturated Soil Mechanics and Engineering", Taylor and Francis, USA, 2007.**
2. **Blight, G.E., "Unsaturated Soil Mechanics in Geotechnical Practice", Taylor and Francis, UK, 2013**
3. **Refereed publications in the field of unsaturated soil mechanics**

5. Similarity with the existing courses: None

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.	Course Name	Course Code	Similarity Content	Approx. % of Content
1.	-	-	-	-

6. Justification of new course proposal if cumulative similarity content is >30%: Not applicable

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: **School:**

Signature: **Date:**

IIT Mandi
Proposal for a New Course

Course number	**:** Exploratory Project
Course Name	**:** CS516P
Credit Distribution	**:** 0-0-6-3 (L-T-P-C)
Intended for	**:** M.Tech.Computer Science and Engineering (CSE)
Distribution	**:** Core for M.Tech in CSE
Semester	**:** Winter Session of Year I
Prerequisite	**:** None
Mutual Exclusion	**:** None

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1. Preamble:

The objective of this course is to provide hands-on experience in exploring different areas in computer science to the M.Tech. (CSE) students after completion of their first-semester course work. This course will not only help them in understanding the practical application of various core and elective courses, but also will prepare them for specializations they may plan to pursue.

The students are expected to identify a problem to solve, read the literature, identify the possible solutions and implement at least one for the solution. In the process, they are expected to identify the research gap and propose a possible direction for future work. To ensure the engagement of each and every student, the projects are supposed to be done individually. Students are encouraged to pursue the same or similar projects as their dissertations.

2. Course Modules with quantitative lecture hours:

It is advisable that the projects should be related to the courses M.Tech.(CSE) students may credit or the specializations that this program offers. Therefore, students can opt for any project in Theoretical Computer Science or Computer Systems or Artificial Intelligence/Machine Learning (AI/ML). Additionally, they are allowed to select a project from other areas, e.g., Human Computer Interaction, Signal Processing and Communications, or Applied Mathematics, as long as the project has 30% or more overlap with any of the three specializations of M.Tech. (CSE) curriculum.

Deliverables: A student must declare the deliverables of her/his project in the initial

project proposal after consulting with the respective mentor(s). While the initial project proposal and the final report carry some marks, a significant portion of the marks, 70% or more, is allotted to the deliverables to emphasize their importance.

Contact hours: On average, a student should work 40 hours per week on her/his project. The students are supposed to meet their respective mentors at least once a week to report their progress.

Evaluation: There will be two evaluations, one in the beginning of the winter vacation and the other one in the beginning of the forthcoming semester. In the first evaluation, the students will be evaluated based on the initial project proposals they have submitted. During the second evaluation, they will be evaluated based on their progress with respect to the promised deliverables, their project reports, and the understanding they have gained from their respective projects.

3. **Text books:**

   Related literature.

4. **References: N/A**

5. **Similarity with the existing courses: N/A**
   (Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%: N/A

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Dileep A. D. **School:** SCEE

Signature:  **Date:**

IIT Mandi
Proposal for a New Course

Course number : CY-524
Course Name : Basic and Applied Electrochemistry
Credit : 3-0-0-3
Distribution : *L-T-P-C*
Intended for : M.Sc Chemistry, MTech, PhD

Prerequisite : Undergraduate level Physical Chemistry courses

Mutual Exclusion : (*courses with high similarity not allowed to credit by the students after or along with this course*)

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1. Preamble:

This course is designed to provide students understanding of the fundamental of electrochemistry and to apply them. The course aims to introduce the concept of thermodynamics, reaction kinetics, transport phenomena in electrochemistry and how these fundamental principles of electrochemistry can be applied for analysis, electrochemical processes used in the industry, battery and fuel cell technologies.

2. Course Modules with quantitative lecture hours:

Topic 1: Interfacial Electrochemistry: (8 Hours)

Introduction and over view of electrochemical processes, Basic electrochemical thermodynamics, free energy, Nernst Equation, half reaction and electrochemical potentials, formal potentials, liquid junction potential, Faradic and non-Faradaic processes, electrode-electrolyte interface, electrical double layer, polarizable and non-polarizable interfaces, Pourbaix diagram, thermodynamics of batteries

Topic 2: Kinetics of Electrode reactions and Measurements:(8 Hours)

Essentials of electrode reactions, Butler Volmmer Model for electrode kinetics, one step-one electron process through potential energy diagram, standard rate constants, symmetry factor and transfer coefficients, Tafel slops, equilibrium condition and exchange current, mechanistic criteria; diffusion, activation phenomena, electron transfer theories, Marcus Theory, electrochemical transport process

Topic 3: Techniques for electrochemical methods: (14 Hours)

Current-potential relationship; methods of measurement of kinetic parameters; over potential, electrochemical Experiments and variables in electrochemical cells, reference electrode, three electrode cell, supporting electrolyte, steady state and potential step techniques; polarography; cyclic voltammetry; chronomethods; convective diffusion systems: rotating disc and ring disc electrodes; microelectrodes; impedance techniques - concepts and applications, Equivalent Circuit Dynamics, differential pulse voltammetry, square wave voltammetry, linear sweep voltammetry

Topic-4: Application of Electrochemistry: (10 Hours)

Pourbaix Diagram and relation to electrochemistry
Fundamentals of batteries: primary, secondary, reserve batteries; solid state and molten solvent- batteries; heterogeneous catalysis, sensor, fuel cells, photo-electrochemical solar cells and conversion of solar energy, Corrosion – fundamentals and applications.

Laboratory/practical/tutorial Modules: 0

3. Text books:

1. **J.O.M Bokris and A.K.N, Reddy Modern Electrochemistry, Volume 1 and 2, *Plenum Press N.Y. (1998)***
2. **A.J. Bard and L.R. Faulkner, Electrochemical Methods second edition, *John Wiley and Son (2001).***

4. References:

1. Scientists A. E.Gileadi,Electrode Kinetics for Chemists, Chemical Engineers and Material (VCH 1993)
2. Berry Rice and Ross, Physical Chemistry *published by OUP USA; 2 edition (11 May 2000)*

5. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	Electrochemical Systems for Energy Engineering	EN510	Electrochemical engineering fundamental, batteries basic	<10%
2.	Chemical thermodynamics and electrochemistry	CY514	Basic electrochemical thermodynamics and kinetics	<10%

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Dr Aditi Halder **School: School of Chemical Sciences**

Signature: **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : EE 541
Course Name : Tensors: Techniques, Algorithms, Applications for Signal Processing, and Machine Learning.
Credit Distribution : 3-0-2-4
Intended for : B.Tech. (3rd/4th year)/ MTech/ MS/ PhD of the SCEE.
Prerequisite : Linear algebra, basic probability, and statistics.
Mutual Exclusion : None (at present)

1. Preamble:

Many modern applications in signal processing for communications and neuroscience, text mining, computer vision, time series, and pattern recognition generate massive amounts of multimodal data. Multimodal data are generally referred to the datasets that are characterized by more than two modes, for example, images, time series data, video, etc. Tensors provide a natural way to represent such datasets. Intuitively, a tensor can be considered a multidimensional array and a generalization of matrices and vectors. Thus, making tensor ubiquitous in signal and data analytics at the confluence of signal processing, statistics, data mining, and machine learning.

The course aims to provide a good starting point for researchers and practitioners interested in learning about and working with tensors. It focuses on the fundamentals required to learn the tensor based techniques. The course aims to strike an appropriate balance of breadth, depth and applications enabling the students to apply, do research, and/ or develop algorithm, and software. The course consists of multilinear algebraic operators and their interpretations; several types of tensor decomposition techniques and their applications in signal processing and machine learning, such as source separation, collaborative filtering, topic modelling, learning HMMs, and algorithmic techniques to compress tensors that retain the inherent properties of the uncompressed one.

2. Course Modules with quantitative lecture hours:

I. *Linear algebra recap:* *(5 hours)*
Vector spaces, subspaces, linear in/dependence, bases, dimensions, principle of orthogonality and projections, linear models least-squares problems, Rank-decomposition for matrix, SVD and low-rank matrix approximation.

II. *Working with Tensors:* *(10 hours)*
Useful products and their properties (Inner, Outer, Hadamard, Kronecker, and Khatri-Rao, and mode-n). Tensor, its different views, and reshaping. Operators on tensors, tensor contraction, their algebraic properties, tensor rank, low rank tensor approximation, Tensor calculus and it's fundamental operations.

III. *Tensor factorization and its computation:* *(9 hours)*
Rank decomposition for tensor, CP decomposition (CANDECOMP/ PARAFAC), properties of CP decomposition, Hardness of CP decomposition, algorithms for computing decompositions (ALS, Jennrich's algorithm, etc.); Other notions of tensor decomposition: Tucker decomposition, HOSVD (higher order SVD), Tensor train decomposition (TT-SVD).

IV. Techniques for compressing tensors: *(8 hours)*
Dimensionality reduction (random projection) for vectors, Tensorized random projection, Compressing Tensors using Count Sketch, Higher Order Count Sketch.

V. Applications: *(10 hours)*
Blind Multiuser CDMA, Blind Source Separation, Harmonics, Gaussian Mixture parameter estimation, learning latent variables, Topic modelling, Learning Hidden Markov Models, Community detection, Collaborative filtering-based recommender systems, including recent ML/ SP based approaches.

Laboratory/ practical/ tutorial Modules:
The two-hours of lab session will enhance the understanding of the concepts taught in the class. The lab will cover the concepts including, principle of orthogonality, least Squares, SVD, low-rank matrix decomposition, Inner, Outer, Hadamard, Kronecker, and Khatri-Rao products, mode-n Tensor, PARAFAC, HOSVD, TT-SVD, ALS, low-rank tensor decomposition, etc.

3. Text books:

[1]. J. Landsberg, Tensors: Geometry and Applications, vol. 128. Providence, RI, USA: Amer. Math. Soc., 2011.

[2]. Haiping Lu, Konstantinos N. Plataniotis, Anastasios Venetsanopoulos, Multilinear Subspace Learning - Dimensionality Reduction of Multidimensional Data, CRC press, 1st Edition, 2015.

4. References:

[3]. Ankur Moitra, Algorithmic aspects of machine learning. Cambridge University Press, 2018.

[4]. T. G. Kolda, B. W. Bader, Tensor Decomposition and Applications. SIAM Review, 2009.

[5]. N. D. Sidiropoulos, L. De Lathauwer, X. Fu, K. Huang, E. E. Papalexakis, and C. Faloutsos, Tensor decomposition for signal processing and machine learning, IEEE Trans. Signal Process., vol. 65, no. 13, pp. 3551–3582, Jul. 2017.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	EE522, CS512, MA512	Linear algebra recap	10%

Approvals:
Other Faculty interested in teaching this course
Proposed by: Dr. Adarsh Patel **School:** SCEE
Signature: **Date:** 02/11/22

Recommended/Not Recommended, with Comments:

_____ **Date:**_____
Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____
Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : **EE 542**
Course Name : **Modelling, Simulation and Control of Hybrid Electric Vehicle**
Credit Distribution : **3-0-0-3**
Intended for : **3rd and 4th year UG, PG, PhD**
Prerequisite : **Linear Algebra**
Mutual Exclusion : **Content of this course does not overlap with others** (*courses with high similarity not allowed to credit by the students after or along with this course*)

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1. Preamble:

Increasing concerns for environmental protection and new stringent laws for emissions have principally driven recent innovations in the field of transportation. Electric vehicles (EV) are emerging as the ultimate transportation solution but there are still many challenges to overcome such as short driving range, significant costs, and lack of ready infrastructure. While electrification of powertrain with higher and cleaner power-output seems to be the most practical and feasible approach, achieving the same requires sophisticated modelling processes and complex control techniques. This course focusses on teaching fundamentals of modelling, simulation and control techniques for developing advanced and more energy efficient components such as electrical machines, multi-body dynamics of vehicle, batteries and fuel cells of higher energy and power density etc.

2. Course Modules with quantitative lecture hours:

Unit 1: Modelling in performance parameter (5 hours)

Topics: Modelling Vehicle Acceleration-Acceleration performance parameters, modeling the acceleration of an electric scooter, modeling the acceleration of a small car

Unit 2: Modelling of Battery Electric Vehicles (8 hours)

Topics: Electric Vehicle Modelling Tractive Effort, Rolling resistance force, Aerodynamic drag, Hill climbing force, Acceleration force, Total tractive effort, Modelling Electric Vehicle Range-Driving cycles, Range modeling of battery electric vehicles, Constant velocity range modelling, Range modelling of fuel cell vehicles, Range modelling of hybrid electric vehicles

Unit 3: Drive Train Characteristics (8 hours)

Topics : Modelling and Characteristics of EV/HEV Power trains Components-ICE Performance Characteristics, Electric Motor Performance Characteristics- Battery

Performance, Characteristics-Transmission and Drive train Characteristics- Regenerative Braking Characteristics-Driving Cycles Modelling and Analysis of Electric and Hybrid Electric Vehicles Propulsion and Braking- Longitudinal Dynamics Equation of Motion-Vehicle Propulsion Modelling and Analysis-Vehicle Braking Modelling and Analysis.

Unit 4: Energy Management (8 hours)

Topics: Handling Analysis of Electric and Hybrid Electric Vehicles-Simplified Handling Models Energy/Power Allocation and Management-Power/Energy Management Controllers-Rule-Based Control Strategies- Optimization-Based Control Strategies

Unit 5: Vehicle Dynamic Control (8 hours)

Topics: Control of Electric and Hybrid Electric Vehicle Dynamics-Fundamentals of Vehicle Dynamic Control (VDC) Systems, VDC Implementation on Electric and Hybrid Vehicles Case Studies, Rechargeable Battery vehicles, Hybrid Vehicles, Fuel Cell Powered Bus

Unit 6: Estimation Techniques (5 hours)

Topics: Identification of important state variables and parameters of HEV, Kalman filter-based methods, Least Square based methods.

3. Text books:

(Relevant and Latest, only 2)

1. Wei Liu, "Introduction to Hybrid Vehicle System Modeling and Control", Wiley, 2015.
2. Y. Xu, J. Yan, H. Qian, and T. L. Lam, "Hybrid Electric Vehicle Design and Control", vol. 1, McGraw Hill, 2021.

4. References:

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd, 2003.
2. Amir Khajepour, Saber Fallahand Avesta Goodarzi, "Electric and Hybrid Vehicles-Technologies, Modelling and Control: A Mechatronic Approach", John Wiley & Sons Ltd, 2014.
3. Antoni Szumanowski, "Hybrid Electric Power Train Engineering and Technology: Modelling, Control, and Simulation", IGIGlobal,2013.
4. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles_ Fundamentals, Theory, and Design, Second Edition", CRC Press,2010.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Dr. Narendra Kumar Dhar **School: SCEE**

Signature:  **Date: 17-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:** _____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : **EE 543**
Course Name : **Vision and Learning Based Control**
Credit Distribution : *3-0-0-3*
Intended for : **3rd/4th year B.Tech. EE, CS, and M.Tech/Ph.D.**
Prerequisite : **None**
Mutual Exclusion : **None**

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1. **Preamble:** This course provides exposure to vision and learning-based control techniques. The course covers a wide range of related topics. The objective is to impart knowledge related to visual servoing, and robot learning along with various applications. By the end of the course, the student will be able to-

   • Understand the role of visual sensors to control different real-time systems
   • Understand the fundamental components of visual servoing
   • Understand the key concept for robot learning by demonstration
   • Understand the utility of imitation learning for practical systems
   • Utilize visual feedback to control the given system of interest

2. **Course Modules:** The modules to be covered in this course are-

   Introduction [1L]: Overview, motivation, and real-world practical applications.

   Visual Sensor Model and Calibration [10L]: Camera model, Coordinate Frames and Transforms, Intrinsic camera calibration, and extrinsic camera calibration.

   Visual Servoing [14L]: Image Jacobian, Robot Jacobian, Image Based Visual Servoing, Position Based Visual Servoing, Eye-in-hand and Eye-to-hand Configurations, Comparison among different class of visual servoing.

   Robot Learning [14L]: Basic concepts of reinforcement learning, reinforcement learning algorithms. Robot learning by demonstration.

   Hybrid Method Design [3L]: Comparative analysis for various methods. Explore, understand and identify different ways to design a hybrid scheme to control the given system of interest. Case study and course projects.

3. Text books:

- Corke, Peter I., and Oussama Khatib. Robotics, vision and control: fundamental algorithms in MATLAB. Vol. 73. Berlin: Springer, 2011.
- Vakanski, Aleksandar, and Farrokh Janabi-Sharifi. Robot learning by visual observation. John Wiley & Sons, 2017.

4. References:

• Ijspeert, Auke Jan, et al. "Dynamical movement primitives: learning attractor models for motor behaviors." Neural computation 25.2 (2013): 328-373.
• Chaumette, François, and Seth Hutchinson. "Visual servo control. I. Basic approaches." IEEE Robotics & Automation Magazine 13.4 (2006): 82-90.
• Chaumette, François, and Seth Hutchinson. "Visual servo control. II. Advanced approaches [Tutorial]." IEEE Robotics & Automation Magazine 14.1 (2007): 109-118.

5. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Dr. Radhe Shyam Sharma **School: SCEE**

Signature: **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

IIT Mandi
Proposal for a New Course

Course number : EP502
Course Name : Informatics for Materials Design
Credit Distribution : *2-0-2-3*
Intended for : BTech 4th Year, M.Sc. Physics, PhD Scholars, M.Tech
Prerequisite : None
Mutual Exclusion : None

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1. Preamble:

The rapid growth of computational technology and information science has led to a new era of advancement in materials science. In past decade, many materials databases have emerged where the theoretical as well as experimental data is collected. But it is not easy to use these databases without huge amount of pre-processing, data integration and deeper domain knowledge. Few efforts using the data-driven approach have shown that the machine learning models that enable rapid predictions based on the past data is a promising approach for material design. But the field of material design using informatics is still in infancy. The objective of this course is to introduce the students to the fast-growing field of material informatics.

Course Modules with quantitative lecture hours (2 Credits):

Unit/Topic 1: (4 Hours) Computational material science:
Crystal Structure and symmetry, Material properties, Property based classification of materials (mechanical, electrical, thermal, magnetic, optical), Performance of materials, Meta materials, Need for new materials.

Unit/Topic 2: (9 Hours) State of art techniques at different length scales
Concept of multiscale modeling, First principles approach, Density Functional Theory (electronic level), Brief introduction to Schrodinger's equation, Overview of most commonly used approximations (Born Oppenheimer, Local Density Approximations), Kohn-Sham equations, Pseudopotentials, Description of the self-consistent field iterations, Total energy minimization, Overview of major algorithms in DFT calculations.

Unit/Topic 3: (6 Hours) Databases and Python Scripting
DBMS fundamentals, Design, Workflows, Query writing, python libraries: Numpy, Panda, Pymatgen, Materials database repositories, Materials open database integration APIs.

Unit/Topic 4: (9 Hours) Introduction to Machine learning for material design
Philosophy behind machine learning, Basic vocabulary terms, Algorithms based on learning: supervised and unsupervised, Regression vs. classification, Regression algorithms, Clustering algorithms, Decision tree algorithms, Interpretability analysis using Lyme/Shap. Model independent Descriptors for material data analytics.

Laboratory/practical/tutorial Modules:

Lab work (1 Credit)

1. Hands on with Quantum Espresso (QE)- 3 Labs
2. Hands on with MySQL- 1 Lab
3. Working with python scripts, use of APIs etc – 2 Labs
4. Creating databases using APIs to fetch material data – 1 Lab
5. Machine learning with Scikit/Weka – 2 Labs

Research project (1 Credit): Based on use of machine learning/Quantum Espresso for understanding material design and its properties for particular applications like magnetic storage, photovoltaic response, electrical conductivity, magnetism and spintronic application.

2. Text books:*(Relevant and Latest, Only 2*)

1. ***June Gunn Lee, Computational Materials science, CRC press,USA 2012***
2. **Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media, Inc. 2019**

3. References:

- ***Online resources for learning SQL, python***
- ***Research papers***

4. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		CS660, CS309, PH523, PH621	This course draws various modules from few courses as per the need of the interdisciplinary nature of the course.	None

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: –

1. **Dr Arnav Bhavsar**
2. **Dr AD Dileep**
3. **Dr R. Padmanabhan**

Proposed by: Arti Kashyap **School: SCEE**

Signature: **Date: May 23, 2022**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi

Proposal for a New Course

Course number : ET504 P
Course Name : Systems Design for Electric Vehicles
Credit : 0-0-3-2 (L-T-P-C)
Prerequisite : None

Intended for : M.Tech in Electric Transportation

Distribution : Core for M.Tech in Electric Transportation students,

Semester: Winter Session of Year I

Mutual Exclusion : NA

Preamble: The objective of this course is to provide hands-on experience in system design to the M.Tech. (ET) students after completion of their first-semester course work. This course will not only help them in understanding the practical application of various core and elective courses, but also will prepare them for specializations they may plan to pursue.

The students are expected to work on modeling, design, and implementation of various subcomponents of EVs with the following key deliverables--Analysis of validated ideas with different case studies and demonstration of key results through software/hardware platforms at the end of the course.

To ensure the engagement of each and every student, the projects are supposed to be done individually. Students are encouraged to pursue the same or similar projects as their dissertations.

Course modules: It is advisable that the projects should be related to the courses M.Tech.(ET) students may credit or the specializations that this program offers. Therefore, students can opt for any project in various subcomponents of EVs. Additionally, they are allowed to select a project from other areas, as long as the project has **30% or more overlap** with any of the three specialization of M.Tech. (ET) curriculum.

Deliverables: A student must declare the deliverables of her/his project in the initial project proposal after consulting with the respective mentor(s). While the initial project proposal and the final report carry some marks, a significant portion of the marks, **70% or more**, is allotted to the deliverables to emphasize their importance.

Contact hours: On average, a student should work 40 hours per week on her/his project. The students are supposed to meet their respective mentors at least once in a week to report their progress.

Evaluation: There will be two evaluations—one in the beginning of the winter vacation and the otherone in the beginning of the forthcoming even semester. In the first evaluation, the students will be graded based on the initial project proposals they have submitted. During the second evaluation, they will be evaluated based on their progress with respect to the promised deliverables, their project reports and the understanding they have gained from their respective projects.

Textbooks: Related literature.

Similarity Content Declaration with Existing Courses: NA

Justification for new course proposal if cumulative similarity content is > 30%: N.A.

Approvals:

Other faculty interested in teaching this course:

Proposed by: School: SCEE

Signature: Date:

Recommended/Not Recommended, with comments:

Chairman, CPC Date:

Approved/Not approved

Chairman, Senate Date

IIT Mandi
Proposal for a New Course

Course number : HS 302
Course Name : Introduction to Drama in English
Credit Distribution : 3-0-0-3
Intended for : Undergraduate
Prerequisite : None
Mutual Exclusion : None

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1. Preamble:

This course aims to introduce students to select texts of drama in English. The course will begin with a study of plays from the classical period and will conclude with contemporary versions of varying theatrical traditions. It intends to enable students to acquire analytical and interpretive skills through the reading of scripts and gain practical experience in script abridgement and performance. Both reading and performance intensive, the course aims to help students explore multiple aspects of drama and performance in English.

2. Course Modules with quantitative lecture hours:

Module 1: Introduction to drama (3 hours)

- Historical overview of the dramatic form
- The basic elements of a play (plot, character, setting, atmosphere, mood, etc.)

Module 2: Tragedies (6 hours)

- Historical overview of tragedies
- Components of tragedies (catharsis, hamartia, dramatic irony, etc.)
- Structure of tragedies
- Revenge tragedy
- Domestic tragedy

Suggested text: William Shakespeare, *Macbeth* (1623); *Hamlet* (c.1509)

Module 2: Comedies (6 hours)

- Historical overview of comedies

- Old comedy and New comedy
- Tragicomedy
- Satire
- Comedy of errors
- Sentimental comedy
- Domestic comedy

Suggested texts: Oscar Wilde, *The Importance of Being Earnest* (1895); Neil Simon, *The Odd Couple* (1965); Northrop Frye, "The Argument of Comedy" (1949)

Module 3: Modern Theatre (11 hours)

- An overview of modern drama
- Expressionism
- Naturalism
- Living newspapers
- Epic theatre
- Theatre of the absurd

Suggested texts: Eugene O' Neill, *The Emperor Jones* (1920); Hallie Flanagan Davis, *E=mc*^{2} (1947); Edward Albee, *The Zoo Story* (1958); Martin Esslin, "The Theatre of the Absurd" (1960)

Module 4: Drama on the Global Stage (8 hours)

- Colonialism and its legacy in theatre
- Politics of language
- Global neo-imperialism

Suggested texts: Wole Soyinka, *Death and the King's Horseman* (1975); Brian Fiel, *Translations* (1980); Manjula Padmanabhan, *Harvest* (1997); Mahesh Dattani, *Dance like a Man* (1989); Helen Gilbert and Joanne Tompkins, *Post-Colonial Drama: Theory, Practice, Politics* (1996)

Module 5: Performing Plays (8 hours)

- This module will be devoted to performances based on plays from or relevant to the syllabus. These performances will be conducted in class and all students are expected to contribute to the performance. The tentative audience for the performance will most likely be the registered participants for the course. Students will be divided into groups after which they will perform portions of a selected play from the syllabus or any play of their choice. Students will be informed about this requirement in the beginning of the course itself so that they can adequately prepare and decide upon possible texts. They are not expected to spend excessive time beyond class hours in preparation for the play—memorizing scripts is only optional, as is the preparation of costumes, props, stage, etc. In lieu of a full-performance, students may also perform a

table reading/ read aloud portions of the play in a simulated theatre setting for the class.

3. Textbooks:

Klaus, Carl H., Miriam Gilbert, and Bradford S. Field, Jr., eds. *Stages of Drama: Classical to Contemporary Theater*, U.S. 2003.

Pickering, Kenneth, *Key Concepts in Drama,* Palgrave Macmillan, U.S. 2005.

4. References:

Albee, Edward. *The Zoo Story,* 1958.

Aristotle, *Poetics,* Penguin Classics, (Revised Edition), U.K. 1996.

Soynika, Wole, "Death and the King's Horseman," in *Contemporary African Plays* by Martin Banham and Jane Plastow, Methuen Publishing, U.K., 1999.

Dattani, Mahesh, *Dance like a Man*, Penguin Petit, (2006)

Esslin, Martin. "The Theatre of the Absurd," *The Tulane Drama Review,* 4.4:3-15, 1960.

Frye, Northrop "The Argument of Comedy." Shakespeare: An Anthology of Criticism and Theory. Ed. Russ McDonald. Malden, MA: Blackwell Publishing, 2004. 94-95, 97.

Gilbert, Helen and Joanne Tompkins. Post-Colonial Drama: Theory, Practice, Politics London: Routledge, 1996.

G.J. Watson, *Drama: An Introduction*, Macmillan Press, U.K. 1983.

Flanagan Davis, Hallie, $E=mc^2$ in *Routledge Drama Anthology and Sourcebook from Modernism to Contemporary Performance* by Maggie B. Gale and John F. Deeney (Editors), U.S. and U.K. 2010.

O'Neill, Eugene. *The Emperor Jones*, Dover Publications, U.S. 2012.

Padmanabhan, Manjula. *Harvest,* Kali for Women, India 1997.

Shakespeare, William, *Macbeth*, Penguin Classics, U.K., 2015.

Shakespeare, William, *Hamlet,* Penguin, Dover Thrift Edition, U.S. 2000.

Simon, Neil. *The Collected Plays of Neil Simon,* Plume, U.S. 1986.

Wilde, Oscar. *The Importance of Being Earnest and other Plays,* Penguin Group, Signet Classics, 1985.

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	-	-	-	-

6. Justification of new course proposal if cumulative similarity content is >30%: N.A.

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Neethi Alexander **School:** SHSS

Signature: **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : **HS 303**
Course Name : **Partition of India: History and Legacy**
Credit Distribution : **3-0-0-3**
Intended for : **B.Tech. (7th and 8th Semesters)**
Prerequisite : **None**
Mutual Exclusion : None

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1. Preamble:

The causes and consequences of the Partition of India are still subjects of much public and academic interest and debate. This course will introduce students to some of the key issues in the study of colonialism, nationalism and decolonization in Twentieth-century India, as seen through the lens of the dramatic events of 1947. It will focus on the causes, processes, events and legacies of Partition, going before and beyond 1947 itself. Students will be able to explore some representations of Partition in literature and film, and appreciate their connections with and divergence from the historical record. While informing students about the major historiographical trends in Partition studies, the course will also familiarize them with conventional as well as novel historical methods and sources. By enabling and encouraging a nuanced study of several dimensions of this seminal event, this course will eventually help students arrive at a multi-faceted understanding of the connections between the past and the present.

2. Course Modules with quantitative lecture hours:

Unit 1: Why is Partition history important? (1 hour) [R3 suggestion incorporated and this new unit has been added.]

a) Interrogating popular understandings of Partition
b) Partition as event and process

Unit 2: Trauma and Memory: Methodologies Old and New (4 hours)

a) What is the relationship between history and memory?
b) Interrogating the archive
c) Potentials and limitations of oral history [R3 suggestion has been incorporated and 'pitfalls' has been replaced with 'limitations'.]

Unit 3: The High Politics of Partition (10 hours)

a) Majorities and minorities in a colonial context: Issues of representation and power
b) Elections of 1937 and 1946
c) Negotiations: The Congress, the Muslim League, and the British

Unit 4: The Partition in Punjab and Bengal: Varying Trends and Trajectories (6 hours)

a) Patterns of violence
b) Refugee relief and rehabilitation

Unit 5: Impact on Cities (5 hours)

a) Evacuee property: custodians and claims
b) Delhi
c) Calcutta

Unit 6: Neglected Histories of Partition (6 hours)

a) Gender – the recovery of 'abducted' women
b) Caste – challenging the idea of the monolithic refugee
c) Region – the experience of Sindh

Unit 7: The 'Long Partition': The Impact of Partition on Indian Polity (4 hours)

a) Minority rights in the Indian Constitution
b) Citizenship: short-term and long-term trends
c) Partition's shadow on the India-Pakistan relationship [R3 suggestion has been incorporated.]

Unit 7: Representing the Partition in Literature and Film (6 hours)

a) Literature – short stories by Rajinder Singh Bedi, Saadat Hasan Manto, Intizar Husain and Ismat Chughtai.

Source book: Bhalla, Alok (ed.). *Stories about the Partition of India*, *Vols I-III*. Publishers, 2011.

b) Film

Ghatak, Ritwik. Meghe Dhaka Tara [The Cloud-Capped Star], 1960.

Sumar, Sabiha. Khamosh Paani [Silent Waters], 2004.

3. Text books:

- Khan Yasmin, *The Great Partition: The Making of India and Pakistan*. Yale University Press, 2008.
- Roy, Haimanti. *The Partition of India*. Oxford University Press, 2018.

4. References:

- Butalia Urvashi. *The Other Side of Silence: Voices from the Partition of India*. Penguin, 1998.
- Chatterji Joya. *Bengal Divided: Hindu Communalism and Partition, 1932- 1947*. Cambridge University Press, 1995.
- Chatterji, Joya. *Spoils of Partition: Bengal and India, 1947–1967*. Cambridge University Press, 2007. [R1 suggestion incorporated.]
- Das, Veena. 'National Honour and Practical Kinship: Of Unwanted Women and Children'. In *Critical Events: An Anthropological Perspective on Contemporary India.* Oxford University Press, 1995.
- Gauba, Kanika. "Forgetting Partition: Constitutional Amnesia and Nationalism." *Economic and Political Weekly*, vol. 51, no. 39, 2016, pp. 41–47. [R1 suggestion incorporated.]
- Hasan Mushirul (ed.). *India's Partition: Process, Strategy and Mobilization*. Oxford University Press, 2001.
- Jalal, Ayesha. *The Sole Spokesman: Jinnah, the Muslim League and the Demand for Pakistan*. Cambridge University Press, 1994.
- Kaul Suvir (ed.), *The Partitions of Memory: The Afterlife of the Division of India*. Permanent Black, 2001.
- Kaur, Ravinder. *Since 1947: Partition Narratives among Punjabi Migrants of Delhi*. Oxford University Press, 2007.
- Malhotra, Aanchal. *Remnants of a Separation: 21 Objects from a Continent Divided*. Hurst & Co. 2019.
- Menon Ritu and Kamala Bhasin. *Borders and Boundaries: Women in India's Partition*. Kali for Women, 2000.
- Nair, Neeti. *Changing Homelands: Hindu Politics and the Partition of India*. Harvard University Press, 2011.
- Pandey, Gyanendra. *Remembering Partition: Violence, Nationalism and History in India*. Cambridge University Press, 2001.

- Talbot, Ian and Gurharpal Singh. *The Partition of India*. Cambridge University Press, 2009.
- Tan Tai Yong and Gyanesh Kudaisya. *The Aftermath of Partition*. Routledge, 2000.
- Zamindar, Vazira Fazila. *The Long Partition and the Making of Modern South Asia*. Columbia University Press, 2007.
- Primary source repository: 1947 Partition Archive (https://in.1947partitionarchive.org/)

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

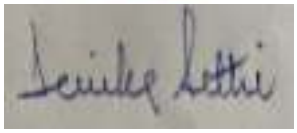
S. No.		Course Code	Similarity Content	Approx. % of Content
1.	India in the 1950s: Biography of a Foundational Decade	HS 524	Module 2: Refugees and Citizens in Independent India	15%

6. Justification of new course proposal if cumulative similarity content is >30%: Not Required.

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: **Dr Devika Sethi** **School: SHSS**

Signature:  **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

IIT Mandi
Proposal for a New Course

Course number : HS546
Course Name : Readings in World Literature
Credit Distribution : *3-0-0-3*
Intended for : Undergraduate and Postgraduate
Prerequisite : None
Mutual Exclusion : None

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1. Preamble:

This course is designed to introduce students to the history and evolution of world literature studies through essays and articles, and to engage them in contemporary debates within and around the discipline of comparative literature. The close readings of a selection of literary texts will expose students to a range of renowned authors, playwrights and poets from around the world and make students aware of the different cultural, historical and socio-economic contexts. The course will moreover explore issues related to the processes of canonization; nationalism, cosmopolitanism, and the planetary; key issues of translation; and the relevance of adaptation as a result of inter-cultural circulation, while also reflecting on the characteristics that make certain texts globally relevant.

2. Course Modules with quantitative lecture hours:

Topic 1: Concepts of "World Literature" – an overview (6 hours)

- *Weltliteratur*
- Comparative / world literature
- Vishwa-sahitya
- Centres and peripheries
- Distant reading
- Untranslatability

Topic 2: Reading across time (9 hours)

- The classics
- The literary canon
- Prize-winning authors
- Forms and mutations
- Colonial / postcolonial writing

Topic 3: Reading across space (9 hours)

- The nationalist and the provincial

- The cosmopolitan writer
- Planetarity and universalism
- The literary marketplace
- Travel, migration, and diaspora
- Alternative communities

Topic 4: Reading in translation (9 hours)

- Role of the translator
- The bilingual / multilingual writer
- Hierarchies of languages
- Translation and gender
- Untranslatability

Topic 5: Reading across cultures (9 hours)

- World literature as a mode of reading
- Resistance and diffusion
- The multicultural text
- Globalization
- New media and the World Wide Web

3. Text books:

1. Damrosch, D. et al., *The Princeton Sourcebook in Comparative Literature*, Princeton University Press, USA, 2009/2021.
2. Martin Puchner, *The Norton Anthology of World Literature (Shorter 4th Edition)*, Vol. 1 & 2, W. W. Norton & Company, USA, 2021.

4. References:

Suggested Reading:

For Topic 1

- Johann Wolfgang Goethe, 'Conversations on *Weltliteratur'*
- Rabindranath Tagore, 'Vishwa-Sahitya'
- Frederic Jameson, 'Third-World Literature in the Era of Multinational Capitalism'
- Franco Moretti, 'Conjectures on World Literature and More Conjectures'
- David Damrosch, 'Conclusion' from *What is World Literature?*
- *Writing About World Literature* by Karen Gocsik (first two chapters)

For Topic 2

- Homer, *The Iliad*, Book 1 (The Wrath of Achilles)
- Vyasa, *The Mahabharata*, Book 5 (The Temptation of Karna)
- Tales from *The Thousand and One Nights*
- Doris Lessing, 'The Old Chief Mshlanga'
- T. S. Eliot, 'What is a Classic?' and 'Tradition and the Individual Talent'
- Ankhi Mukherjee, 'Introduction' in *What is a Classic?*

For Topic 3

- W. B. Yeats, 'The Lake Isle of Innisfree'
- Louis Aragon, 'The Rose and the Reseda'
- Sadat Hasan Manto, 'Toba Tek Singh'
- Julio Cortázar, 'House Taken Over'
- Sheldon Pollock, 'Cosmopolitanisms'
- Judith Butler, 'Universality in Culture'
- Pheng Cheah, 'What is a World? On World Literature as World-making Activity'

For Topic 4

- Rabindranath Tagore, 'The Hungry Stones'
- Nikolai Gogol, 'Diary of a Madman'
- Lu Xun, 'Diary of a Madman'
- Samuel Beckett, *Not I*
- Gayatri Spivak, 'The Politics of Translation'
- Emily Apter, 'A New Comparative Literature'

For Topic 5

- J. M. Coetzee, 'The Dog'
- Yoko Tawada, 'The Bridegroom was a Dog'
- Kow Shih Li, 'Peach Blossom Luck'
- Marjane Satrapi, selections from *Persepolis*
- Jorge Luis Borges, 'The Argentine Writer and Tradition'
- Salman Rushdie, 'Imaginary Homelands'

Further references:

- Apter, E. 2013. *Against World Literature: On the Politics of Untranslatability*. London: Verso.
- Bassnett, S. (Ed) 2019. *Translation and World Literature.* New York: Routledge.
- Casanova, P. 2004. *The World Republic of Letters*. Trans. M. B. DeBevoise. Cambridge: Harvard University Press.
- Damrosch, D. 2003. *What is World Literature?* Princeton: Princeton University Press.
- Dev, A. and Das, S. K. 1988. *Comparative Literature: Theory and Practice.* Shimla: IIAS.
- Mufti, A. 2016. *Forget English! Orientalisms and World Literatures*. Cambridge: Harvard University Press.
- Mukherjee, A. 2014. *What is a Classic? Postcolonial Rewriting and Inevention of the Canon.* Stanford: Stanford University Press.
- Ramakrishnan, E. V. et al (Eds). 2013. *Interdisciplinary Alter-Natives in Comparative Literature.* New Delhi: Sage.

- Zepetnek, S., & Mukherjee, T. (Eds.). 2014. *Companion to Comparative Literature, World Literatures, and Comparative Cultural Studies*. Cambridge: Cambridge University Press.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	N/A	N/A	N/A	N/A

6. Justification of new course proposal if cumulative similarity content is >30%: N/A.

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Thirthankar Chakraborty **School:** SHSS

Signature: **Date:** 12/09/2022

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number	**:** HS 547
Course Name	**:** Philosophy of Texts and Narratives
Credit Distribution	**:** 3-0-0-3
Intended for	**:** Ph.D., Masters, Advanced B.Tech. students
Prerequisite	**:** None
Mutual Exclusion	**:** None

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1. Preamble:

This course introduces students to a set of philosophical approaches to the study of texts and narratives. They will learn how texts and narrative forms can be studied by placing them in the network of intentionalities within which they are produced and consumed. More precisely, texts will be seen as artefacts, i.e. being constituted within specific traditions, interacting with and reacting to other texts, and enabled and constrained by certain structures and patterns. Given the ubiquity of texts, intellectual or otherwise, in our lives, and in different societies, a need is felt to understand what a text is in the first place, and how, depending on different contexts, lends itself to various transformations and performance modes. This course is designed to clearly articulate and address this need as an exigent, recognising that a naïve approach to texts not only does not yield much in terms of signification, it in fact hampers their proper appreciation. The course also looks at various narrative forms, from literature to myth to history, as embodying particular textual configurations and offers insights on how the same can be investigated. From more recognised concerns like those of genre, utterances, intertextuality, intermediality etc., the course ventures to introduce students to more contemporary approaches of broaching the textual condition. By raising questions on the self-evident universality of literature, to articulating the same in systemic terms, the course also explores the possibility of understanding texts beyond the contours set by the usually understood norms of textuality. Finally, the students of this course will come to see how a philosophical approach to texts and narratives goes further and deeper than the allied discipline of literary theory, which is often only concerned with methods of reading and analysis. The

course will be beneficial for research scholars, post-graduates and advanced undergraduates across various streams, and will enable them to pose pertinent questions to texts and narratives they encounter as well as use in the process of their studies and research.

2. Course Modules with quantitative lecture hours:

Unit 1: Philosophical Underpinnings and Key Concepts (12 hours)

- What is a Text?
- Text and Signs
- Text and Genre
- Intertextuality
- Intermediality
- Translation

Unit 2: Narrative Forms, Structures and Time (10 hours)

- Text and Narrative
- Narrative forms
- Order in Narrative
- Time and Narrative
- Historical Narration

Unit 3: Literary Narratives and the Question of Realism (10 hours)

- Fiction
- The Limits of Fictionality
- Epic and Novel
- Realism and Irrealism
- Is Literature a Universal?

Unit 4: Beyond Text? (10 hours)

- Literary System
- World Literature
- Planetary Textuality
- Science Fiction
- Beyond Text?

Laboratory/practical/tutorial Modules: NA

3. Text books:

1. **Duff, D (Ed.). 2014. *Modern Genre Theory*. London: Routledge.**
2. **McQuillan, M (Ed.). 2000. *The Narrative Reader*. London: Routledge.**

4. References:

1. Bakhtin, M. 1986. *Speech Genres and Other Late Essays*. Edited by Caryl Emerson and Michael Holquist. Translated by Vern W. McGee. Austin, Texas: University of Texas Press.
2. Barber, K. 2007. *Anthropology of Texts, Persons and Publics: Oral and Written Culture in Africa and Beyond*. Cambridge: Cambridge University Press.
3. Barthes, R. 1967. *Elements of Semiology*. New York: Hill and Wang.
4. Barthes, R. 1974. *S/Z*. Translated by Richard Miller. New York: Hill and Wang.
5. Benjamin, W. 2019. *Illuminations: Essays and Reflections*. Edited by Hannah Arendt. Translated by Harry Zohn. Boston: Mariner Books.
6. Bohannan, L. 1966. 'Shakespeare in the Bush'. Available at: https://www.naturalhistorymag.com/editors_pick/1966_08-09_pick.html
7. Danto, AC. 1985. *Narration and Knowledge*. New York: Columbia University Press.
8. Even-Zohar, I. 1990. 'The Literary System' *Poetics Today*, Vol. 11 (1): 27-44.
9. Genette, G. 1980. *Narrative Discourse: An Essay in Method*. Translated by Jane E. Lewin. Ithaca, New York. Cornell University Press.
10. Ghosh, A. 2016. *The Great Derangement: Climate Change and the Unthinkable*. Gurgaon: Penguin Random House India.
11. Goodman, N. 1977. *Ways of Worldmaking*. Indianapolis: Hacket Publishing.
12. Jameson, F. 2013. *Antinomies of Realism*. London: Verso.
13. Kristeva, J. 1980. *Desire in Language: A Semiotic Approach to Literature and Art*. Edited by Leon S. Roudiez. Translated by Thomas Gore, Alice Jardine, and Leon S. Roudiez.
14. Lamarque, P. 1990. 'Narrative and Invention: The Limits of Fictionality', in Christopher Nash (ed.) *Narrative in Culture: The Uses of Storytelling in the Sciences, Philosophy, and Literature*. London: Routledge, 133-156.
15. Le Guin, UK. 1980. *The Left Hand of Darkness*. New York: Harper and Row.
16. Lévi-Strauss, C. 1973. 'Structure and Form: Reflections on a Work by Vladimir Propp', in *Structural Anthropology 2*. Translated by Monique Layton. Harmondsworth: Penguin Books, 115-145.
17. Lévi-Strauss, C. 1986. *The Raw and the Cooked*. Translated by John and Doreen Weightman. New York: Harper and Row.
18. Moretti, F. 2005. *Graphs Maps Trees: Abstract Models for a Literary Theory*. London: Verso.
19. Mbembe, A. 2001. *On the Postcolony*. Berkeley: University of California Press.
20. Propp, V. 2009. *Morphology of the Folktale*. Translated by Laurence Scott. Edited by Louis A. Wagner. Texas: University of Texas Press.
21. Ricoeur, P. 1984. *Time and Narrative, Vol. 1*. Chicago: The University of Chicago Press.
22. Wolf, W. 2018. *Selected Studies on Intermediality by Werner Wolf (1992-2014)*. Edited by Walter Bernhart. Leiden: Brill Rodopi.
23. Ong, W. J. 2002. *Orality and Literacy*. London. Routledge.

5. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Saumya Malviya **School: SHSS**

Signature:  **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:** _____

Chairperson, CPC

Approved / Not Approved

_____ **Date:** _____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : HS 548
Course Name : Science and Society
Credit Distribution : 3-0-0-3
Intended for : Ph.D., Masters, Advanced B.Tech. students
Prerequisite : None
Mutual Exclusion : None

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1. Preamble:

This course is aimed at helping students develop a critical understanding of deeply entrenched notions about science, objectivity, truth, representation etc., and arrive at a deeper and more situated understanding of science as a social activity. Located broadly within the disciplines of Science and Technology Studies and Sociology of Science, the course also touches upon key philosophical as well as policy-oriented concerns to explore whether and how science is informed by socio-cultural values. Further, it also encourages students to question the taken for granted demarcations between Science, Society and Nature, to see their interlinkages and the assemblages they constitute, such that their separate and fixed identities are revealed as more fabricated than real. Students will be exposed to classic texts in the tradition of sociologically inclined studies of science, which include some pathbreaking ethnographic studies of scientific practices as well. This will give them a wealth of insights into the making of science, which is bound to unsettle the assumptions which arise when we take science as a finished product. Reading and discussing major texts on science and its relationship with politics and statist imaginaries, students will also be learning to debate science in so far as it has a bearing on questions related to policy, law and governance. With an exposure to the ways in which epistemic values are intertwined with social, cultural, moral, political, and religious values students will be able to develop a more reflexive viewpoint on the disciplines in which they are trained or undergoing their training in, to become more aware of the disciplinary assumptions which govern the production and consumption of knowledge. The course is addressed to students from different disciplines, and is designed such that it engages with

diverse traditions of scientific knowledge in sociologically, historically and philosophically nuanced ways.

2. Course Modules with quantitative lecture hours:

Unit 1: Science, Values and the Social: (12 hours)

- What is Science?
- The 'Epistemic', the 'Cognitive', and the 'Social' in Science
- Is Science Value-Free?
- The Normative Structure of Science
- Normal Science and the Structure of Scientific Revolutions
- Scientific Objectivity

Unit 2: Construction of Facts (10 hours)

- Construction of Scientific Facts
- 'Social' *in* 'Science' *and* 'Science' *in* 'Social' or the Mutual Constitution of Science and Society
- Scientific Objects
- Truth and Representation in the Sciences
- Circulating Reference: 'Context' and 'Content' of Science

Unit 3 Practices of Science (10 hours)

- Scientific Practices
- Epistemic Cultures
- Science as a Vocation, Technical Life, and the Scientist as an Individual
- Social Epistemology of Experiments
- (En)gendered Science

Unit 4 Science, Democracy and Governance (10 hours)

- Expertise and Science
- Politics of Science: Science as Ideology
- Infrastructural Imaginaries
- Debating Science Policies
- Science and Citizens

Laboratory/practical/tutorial Modules: NA

3. Text books:

1. **Machamer, P and Wolters, G (Eds.). 2004. *Science, Values, and Objectivity*. Pittsburgh: University of Pittsburgh.**
2. **Sismondo, Sergio. 2004. *An Introduction to Science and Technology Studies*. Malden, USA. Blackwell Publishing Ltd.**

4. References:

1. Biagioli, M (Ed.). 1999. *The Science Studies Reader*. New York, NY: Routledge.
2. Daston, L (Ed.). 2000. *Biographies of Scientific Objects*. Chicago: University of Chicago Press.
3. Daston L, Galison P. 1992. 'The Image of Objectivity'. *Representations* 40 (special issue): 81-128.
4. Douglas, H. 2009. *Science, Policy, and the Value-free Ideal*. Pittsburgh: University of Pittsburgh.
5. Fleck, L. 1979. *Genesis and Development of a Scientific Fact*. Chicago: The University of Chicago Press.
6. Galison, P. 1987. *How Experiments End*. Chicago: The University of Chicago Press.
7. Golinski, Jan. 1998. *Making Natural Knowledge: Constructivism and the History of Science*. Cambridge, UK: Cambridge University Press.
8. Hess, D. 1997. *Science Studies: An Advanced Introduction*. New York: New York University Press.
9. Jasanoff, S (Ed.). 2004. *States of Knowledge: The Co-Production of Science and Social Order*. London: Routledge.
10. Kuhn, T.S. 2012. *The Structure of Scientific Revolution*. Chicago: University of Chicago Press.
11. Knorr Cetina, K. 1999. *Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge, Massachusetts: Harvard university Press.
12. Latour, B. and Woolgar, S. 1986. *Laboratory Life: The Construction of Scientific Facts*. Princeton, New Jersey. Princeton University Press.
13. Latour, B. 1999. Pandora's Hope: Essays on the Reality of Science Studies. Cambridge: Harvard University Press.
14. Leach, M, I. Scoones, and B. Wynne (Eds.). 2005. *Science and Citizens: Globalization and the Challenge of Engagement*. London: Zed Books.
15. Lewontin, R. 1992. *Biology as Ideology: The Doctrine of DNA*. New York: Harper Perennial.
16. Merton, R, N. Storer. 1973. *The Sociology of Science: Theoretical and Empirical Investigations*. Chicago: The University of Chicago Press.
17. Mitchell, T. 2002. *Rule of Experts: Egypt, Techno-politics, Modernity*. Berkeley: University of California Press.
18. Porter, T.M. 2020. *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*. Princeton, New Jersey: Princeton University Press.
19. Sarukkai, S. 2005. 'Revisiting the 'Unreasonable Effectiveness' of Mathematics'. Current Science, Vol. 88(3): 415-423.
20. Sarukkai, S. 2012. *What is Science?* New Delhi: National Book Trust, India.

21. Shapin, S and Schaffer, S. 1985. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton: Princeton University Press.
22. Sukumar, AM. 2019. *Midnight's Machines: A Political History of Technology in India.* New York: Penguin Random House.
23. Weber, M. 1946. 'Science as a Vocation'. In Gerth HH and C Wright Mills (Eds.). From Max Weber: Essays in Sociology. New York: Oxford University Press, 129-156.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	Science, Technology and Society	HS353	One subtopic in module 1: 'Structure of Scientific Revolutions'.	< 5%

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Saumya Malviya **School: SHSS**

Signature:  **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:** _____

Chairperson, CPC

IIT Mandi

Proposal for a New Course

Course number : HS 549

Course Name : Indian Literatures in English Translation

Credit Distribution : 3-0-0-3

Intended for : B.Tech./M.Tech/M.A./Ph. D students

Prerequisite : None

Mutual Exclusion : None

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1. **Preamble:** Though the course explores themes in Indian literatures spinning around the genres of poetry, drama, short story and the more recent novel, it also includes some folk tales from the A&N which are translations not exactly from a written source. Otherwise, the course aims at exploring literatures produced in different Indian languages which have been translated into English. Hence, *Indian Literature* and *Translation* are two broad categories that would be interrogated in the course. In order to serve the purpose, a wide range of literary selections are made from different Indian language literatures. Representation is given to as many linguistic regions as possible. While the novel and the short story depict the Western impact and a response to it, the classical Sanskrit drama and poetry are expressions of Indian aesthetics and themes.

2. **Course Modules with quantitative lecture hours:**

Module 1: Introduction to Indian Literature **8 hours**

- Defining Indian Literature
- Indian Language Literatures
- The Postcolonial Nation State
- De-coloniality
- Translation from English into Indian languages and vice versa

Module 2: Drama **6 hours**

- Dramaturgy
- Ancient Drama

- Modern Drama

Suggested Texts: Kalidasa's *Malavika and Agnimitra*, Visakhadatta's *Rakshasa's Ring*. *Wild Harvest* by Manoranjan Das, Sahitya Akademy 1994, and Bharatendu Harishchandra's *Andhernagari Chowpatraja*. (*The City of Darkness).*

Module 3: Novels **12 hours**

- Novels published on the cusp of Independence
- Issues of nationalism and the impact of Gandhian ideals
- Colonial modernity/rationality

Suggested Texts: Unnava Lakshmi Narayana's *Malapalli,* Kuvempu's *Bride in the Rainy Mountains,* and Phaneeshwarnath Renu's *Maila Anchal.*

Module 4: Short Story **8 hours**

- Narrative
- Oral and Written Literature
- Translation from source language to target language

Suggested Texts: *Folktales from Andaman and Nicobar***,** Rahul Sankrityayan *Volga to Ganga*. Premchand's short stories from *The Complete Oxford Premchand***,** Vaikom Mohammed Basheer's *Poovan Banana and Other Stories,* and Damodar Majo's *These Are My Children***,** Tarashankar Bandopadhyaya's "Boatman Tarini" and *Collected short stories from the North East.*

Module 5: Poetry **8 hours**

- Gender.
- Buddhist Literature.
- Proscription in the 19 C.

Suggested Texts*:* Selections from *Therigatha,* Ilango Atikal's *Silappadikkaram* (1939), Muddupalani's *Radhika Santvanamu* (*Appeasing Radhika*), & Amrita Pritam's – "An Ode to Waris Shah."

3. Text Books

Bassnett, Susan. *Comparative Literature.* Oxford: Wiley-Blackwell, 1993.

Das, Sisir Kumar. *History of Indian Literature* 1800-1910 & 1911-1956*. Vol. I&II.* New Delhi: Sahitya Akademi, 1991.

George, K.M. *Comparative Indian Literature*. *Vol. I, II&III.* New Delhi: Sahitya

Akademi,1994.

3.a. References

Basheer, Vaikom Mohammed. *Poovan Banana and Other Stories.* New Delhi: Orient BlackSwan,1994.

Bhattacharya. Bhabani. (Ed) *Contemporary Indian Short Stories*. New Delhi: Sahitya Akademi,1958.

Bharata. Manmohan Ghosh. (Transl) *Natya Shastra*.Vol. I&II Calcutta: Asiatic Society of India, 1951.

Biguenet, John and Rainer Schulte (eds). *Translation Theories: From Dryden to Derrida*. Chicago: University of Chicago Press, 2020.

Bodhi, Bikku. (Ed). *Great Disciples of the Buddha*. Boston: Wisdom Publications, 2003.

Das, Manoranjan. Prabhat Nalini Das (Transl). *Wild Harvest*. New Delhi: Sahitya Akademy,1994.

Forster, E. M. *Aspects of the Novel*. New York: Harcourt Brace and World, 1954.

Harishchandra, Bharatendu. *The City of Darkness*. (Amarchitrakatha Series) *Andher Nagari Chowpatraja.* (Hindi).

Kalidasa. Daniel Balogh and Eszter Somogyi. (Transl) *Malavika and Agnimitra*. New York: NYU Press, 2009.

Kothari, Rita. *Translating India*. New Delhi: Routledge, 2003.

Kuvempu.K.M. Srinivasa Murty and G.K.Srikanta Murthy (Transl). *Bride in the Rainy Mountains*. Kuppali: Kuvempu Trust, 2020.

Lakshiminarayana, Unnava. V.V.B.Rama Rao. (Transl). *Malapalli*. New Delhi: Sahitya Akademi, 2008.

Ilango Atikal. V.R. Ramachandra Dikshitar (Transl). *Silappadikkaram*. Oxford: OUP,1939.

Lukacs, George. *The Theory of the Novel*. Massachusetts: MIT Press, 1974.

Mauzo, Damodar. *These Are My Children*. New Delhi: Katha Publishers, 2019.

Muddupalani. Narayana Rao and Shulman (*Tansl*) *Radhika Santvanamu* (*Appeasing Radhika*). Hyderabad: Telugu University Publications,2008.

Mukherjee, Meenakshi. *Realism and Reality*. New Delhi: OUP,1999.

Mukherjee, Sujit. *Towards a Literary History of India*. Simla: IIAS, 1975.

Munday, Jeremy. (ed.) *The Routledge Companion to Translation Studies*. London & New York: Routledge, 2009.

Narayana Rao and Shulman. *Classical Telugu Poetry*. New Delhi: OUP, 2004.

Paz, Octavio. “Literature and Letters”. Translated by Irene del Corrall.

Premchand. *The Oxford India Premchand*. New Delhi: OUP, 2004.

Pritam, Amrita. *Selected Poems of Amrita Pritam*. Calcutta: Dialog Calcutta, 2019.

Raveendran, P. P. "Genealogies of Indian Literature" *Economic and Political Weekly*, Vol. 41, No. 25 (Jun. 24-29, 2006), pp. 2558-2563.

Renu. Indira Junghare. (Transl). *The Soiled Border*. Chanakya Publications: New Delhi, 1991.

Roychowdhury, Rabin. (ed.) *Folktales from Andaman and Nicobar***.** New Delhi: Sahitya Akademi, 2017.

Sai Deepak, J. *India, that is Bharat: Coloniality, Civilization, Constitution*. New Delhi: Bloomsbury India, 2021.

Sankrityayan, Rahul. Victor Kiernan (Transl). *Volga to Ganga*. Mussoorie: Rahul Publication, 1953.

Tarashankar. "Boatman Tarini." From *Contemporary Indian Short Stories*. New Delhi: Sahitya Akademy,1958.

Tharu & Lalita. *Women Writing in India* Vol. I. New Delhi: OUP,1991.

Tharu & Lalita. *Women Writing in India* Vol. II. New Delhi: OUP,1993.

Visakhadatta. Michael Coulson (Transl) *Rakshasa's Ring*. New York: New York University Press, 2017.

Unknown. Mahendra, Angaraka.(Transl). *Therigatha.* Roslindale: Dhamma Publishers, 2017.

Collected short stories from the North East. Calcutta: Zubaan,

4. Similarity with the existing courses: N.A.

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	-None	-	-	-

5. Justification of new course proposal if cumulative similarity content is >30%: N.A.

-NA

6. Evaluation:

75% of attendance is mandatory to pass the course.

Assignment I- 30M

Assignment II-30M

Assignment III-40M

Approvals:

Other Faculty interested in teaching this course:

Proposed by: Aruna Bommareddi **School: H&SS**

Signature: **Date: 18.9.2022**

Recommended/Not Recommended, with Comments:

_____ **Date:**

Chairperson, CPC

Approved / Not Approved

_____ **Date:** _____

Chairperson, BoA

Course Number : IC102P
Course Name : Foundation of Design Practicum
Credit Distribution : 3-0-2-4
Intended for : UG
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

The course gives an outline of the steps in solving an engineering design problem through an example of a robot building. The course is multidisciplinary of its kind and will be used to bring out the multidisciplinary aspects of a typical engineering design problem. The course unravels the different steps of engineering problem solving culminating in the development of a robot.

2. Course Modules with quantitative lecture hours:

Introduction: Engineering design - How to select an engineering problem, stages of solving a problem, documentation in Engineering, Machine and a robot - Different aspects of robotics, current problems in robotics. Drives and motion, pneumatic, hydraulic systems, clutch and brake. **(3 hours)**

Practical 1: Microelectronics, onboard computer, IoT, embedded electronic and materials to be used in the lab Manufacturing techniques - additive and subtractive manufacturing. **(3 hours)**

Design of Mechanical Systems: Introduction to CAD by 3D modeling software, Drawing of parts and assemblies, Computer-Aided Manufacturing and prototyping, Brief Introduction to robotic systems, Joints and transformations on ROS. **(5 hours)**

Practical 2: Introduction to Mechanical assembly, bill of materials, 3D modeling software and design of parts and assemblies and Static Stress Simulation. **(3 hours)**

Practical 3: Simulation in ROS environment (**3 hours)**

Integration of Intelligent Control: Sensor and Actuator selection and sizing, Determination of Power Source, Design of Power distribution, microcontroller, and motor driver circuits, Developing PCB boards and feasibility testing, Introduction to standard electronic connectors and American Wire Gauge. **(7 hours)**

Practical 4: Sizing of sensors motors and linear actuators and integration into mechanical design. (3 hours)

Practical 5: Circuit Design using CAD tool and making PCBs manually and demonstration of CNC based PCB printing. (3 hours)

Programming and Signals: Introduction to Programming; procedural vs object-oriented programming, Object-Oriented programming in practice, Signals; communication via PWM, UART, Design of hardware and software interrupts. **(6 hours)**

Practical 6: Introduction to Programming; procedural vs object-oriented programming. **(3 hours)**

Practical 7: Signals; communication via PWM, UART; connecting two microcontrollers. **(3 hours)**

Practical 8: Design of hardware and software interrupts. **(3 hours)**

Integration of Compute and networks: Introduction to microcontroller coding and interfacing with the ros API, Introduction to ROS packages and their deployment, Introduction

to IoT and IP sending receiving packets on client-server networks, Control of robotic platforms over IP, Deployment of real-time decision pipelines on the robot. **(6 hours)**

Practical 9: Intro to rosserial and connecting microcontrollers to ROS. **(3 hours)**

Practical 10: Introduction to esp8266; control via blynk. **(3 hours)**

Practical 11: Deployment of conditional path planning on robot and testing. **(3 hours)**

Final project: Project towards design and development of functional Robotic system.

3. Textbooks:

1. Robot Builder's Cookbook - Owen Bishop
2. Autodesk Fusion 360- Gaurav Verma
3. Introduction to SOLIDWORKS: A Comprehensive Guide with Applications in 3D Printing - Godfrey C. Onwubolu

4. References:

1. Programming Robots with ROS - Morgan Quigley, Brian Gerkey

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None

Approvals:

Other Faculty interested in teaching this course: CAIR faculty

Proposed by: CAIR faculty **School/Centre: CAIR**

Signature: **Date: 18-01-2023**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi

Proposal for a New Course

Course number : IC-112
Course Name : Calculus
Credit Distribution : *1.5-0.5-0-2*
Intended for : B. Tech. 1st Year
Prerequisite : Consent of the faculty member
Mutual Exclusion : (*None)*

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1. Preamble:

This course is an introduction to basic concept of Analysis. The course starts with discussion of real number system. This is an important part of the foundation of Mathematical Analysis. Next we will cover elementary calculus (Limit, continuity and differentiability) in single variable. The concepts of limit, continuity and differentiability will be then extended to functions of several variables. Several other important topics like partial derivatives, Tangent and Normal Plane, finding extrema of functions of two variables will also be covered. Finally the course deals with the idea of sequence, series and their convergence.

2. Course Modules with quantitative lecture hours:

Unit 1: Elementary calculus: Real number system, Zeno's Paradox , Limit Continuity and Differentiability of single variables, Uniform continuity, Taylor series, Partial Derivatives. [6 Lectures]

Unit 2: Functions of Several Variables: Limit , Continuity and differentiability of functions of two variables. Euler's Theorem, Tangent plane and Normal, Change of variables, Chain rule. Jacobians, Taylor's Theorem for Two Variables, Extrema of Functions of Two variables, Lagrange's method of undetermined multipliers. [8 Lectures]

Unit 3: Infinite Series: Achelles' and Tortoise Problem, Sequences, Convergence of Infinite Series of Real Numbers, Comparison Test, Ratio Test, Root Test, Raabe's test, Logarithmic test, Demorgan's test, Sequence and series of functions: Uniform convergence and related tests. [7 Lectures]

3. Text books:

1. Thomas and Finney, Calculus and Analytical Geometry, 9th Edition, Addison and Wesley Publishing Company, 1996
2. W. Rudin, Principles of Mathematical Analysis.

4. References:

1. *E. Kreyszig, Advanced Engineering Mathematics, 10th Edition.*
2. *J. E. Marsden, A. J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer, 1993.*
3. *Apostol, Mathematical Analysis,2nd Edition.*

5. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: **School:**

Signature: **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

IIT Mandi
Proposal for a New Course

Course number : IC 113
Course Name : Complex and Vector Calculus
Credit Distribution : *(1.5-0.5-0-2)*
Intended for : B. Tech. 1st Year
Prerequisite : Math 1
Mutual Exclusion : (None)

1. Preamble:

This course is designed to provide exposure of the concept of complex analysis and vector calculus. The principal aim of unit 1 is to make students understand the central concept of complex analysis: Limit, continuity and differentiability of functions of complex variables, Cauchy- Riemann equation, Cauchy's integral formula, Taylor and Laurent series, different types of singularity etc. Unit 2 aims at equipping the students with the knowledge of double integral and its application, Fubini's theorem that allows to interchange integration with respect to x and y variables and explaining how multiple integral problems can be transformed into polar, cylindrical and spherical coordinates.

2. Course Modules with quantitative lecture hours:

Unit 1: Complex variable: Limit, continuity, differentiability and analyticity of functions, Cauchy-Riemann equations, line integrals in complex plane, Cauchy integral theorem, independence of path, existence of indefinite integral, Cauchy's integral formula, derivatives of analytic functions, Taylor's series, Laurent's series, Zeros and singularities, Residue theorem, evaluation of real integral [10 Lectures]

Unit 2: Integration: Riemann integral, Double integral and its applications, Fubini's theorem, Volumes and Areas, Change of variable in double integral. Special cases: Polar coordinates, Triple integral, Applications, Change of variable in triple integral. Special cases: Cylindrical and Spherical coordinates, Surface area, Surface integral, Line integrals, Green's theorem, Vector fields Divergence and Curl of a vector field, Stoke's theorem, The divergence theorem. [11 Lectures]

3. Text books:

1. **Thomas and Finney, Calculus and Analytical Geometry, 9th Edition, Addison and Wesley Publishing Company, 1996.**
2. **R. V. Churchill and J. W. Brown, Complex Variables and Applications, 9th Editions, 2021.**

4. References:

1. ***E. Kreyszig, Advanced Engineering Mathematics, 10th Edition.***
2. ***S. Ponnusamy, Foundations of Complex Analysis, 2nd Edition, Narosa, 1995.***
3. ***J. E. Marsden, A. J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer, 1993.***

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: **School:**

IIT Mandi
Proposal for a New Course

Course number : IC-114
Course Name : Linear Algebra
Credit Distribution : *2-0-0-2*
Intended for : B.Tech 1st year
Prerequisite : None
Mutual Exclusion : None

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1 **Preamble:** Linear algebra is a branch of mathematics concering linear equations and linear maps. Linear algebra is used in most sciences and fields of engineering because it allows modeling many natural phenomenon, and computing efficiently with such models. This course will cover the analysis and implementation of algorithms used to solve linear algebra problems in practice. This course will enable students to acquire further skills in the techniques of linear algebra, as well as understanding of the principles underlying the subject.

2 **Course Modules with quantitative lecture hours:**

Unit 1: Matrix Theory: Rank of Matrix, inverse of a matrix by elementary operations, Solution of linear simultaneous equations and their numerical solutions by gauss Elimination and Gauss Seidel Methods. Eigen values and eigen vectors, Cayley Hamilton Theorem, Diagonalization of Matrices. Orthogonal, Hermitian, Skew Hermitian, Normal and Unitary matrices and their elementary properties, Quadratic Forms. [7 Lectures]

Unit 2: Vector Spaces: Vector spaces, Sub Spaces, Linear Dependences and Independences of Vectors, Span, Bases and Dimensions, Direct Sum. [7 Lectures]

Unit 3: Linear Transformations: Linear Transformations, Linear Variety, Range Space and Rank, Null Space and Nullity, Homomorphism, Matrix of Linear Transformations, Matrix Representation of a linear transformation, Structure of the solutions of the matrix equation Ax = b, Change of bases. [7 Lectures]

3 Text books:

1. G. Strang: Linear Algebra, Introduction to linear algebra, 41 Edition, Wellesley Cambridge Press.

2. Kenneth Hoffman and Ray Kunze: Linear Algebra, PHI publication.

4 References:

5 Similarity with the existing courses: None
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: – All SMSS Faculty

Proposed by: Dr. Muslim Malik **School: SMSS**

Signature: **Date: 06th July, 2023.**

Recommended/Not Recommended, with Comments:

_____ **Date:_____**

Chairperson, CPC

Approved / Not Approved

_____ **Date:_____**

IIT Mandi
Proposal for a New Course

Course number : IC-115
Course Name : ODE and Integral transform
Credit Distribution : *2-0-0-2*
Intended for : B.Tech 1st year
Prerequisite : None
Mutual Exclusion : None

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1 **Preamble: Ordinary differential equations (ODEs) arise in many contexts of mathematics and social and natural sciences. Mathematical descriptions of change use differentials and derivatives. Various differentials, derivatives, and functions become related via equations, such that a differential equation is a result that describes dynamically changing phenomena, evolution, and variation. Often, quantities are defined as the rate of change of other quantities (for example, derivatives of displacement with respect to time), gradients of quantities, which is how they enter differential equations.** Differential equations are very important field in terms of applications as well as theory. This course introduces techniques for solving ordinary differential equations.

2 **Course Modules with quantitative lecture hours:**

Unit 1: Ordinary Differential Equations: Origin of differential equations, Formation of differential equations, Order and degree, Equation of first order and first degree, Solution of linear differential equations with constant coefficients, Euler Cauchy Equations, Solution of Second Order differential Equations by change of dependent and independent variables, Method of variation of parameters for second order differential equations, Series solution. [13 Lectures]

Unit 2: Integral transforms: Laplace and Fourier transform, existence, linearity property, shifting property, Inverse Laplace and Fourier, Melin transform, Fourier series [8 Lecture]

3 Text books:

1. G. F. Simmons: Ordinary Differential Equations, Differential equations with applications and historical notes, 2nd Edition.

2. S. L. Ross, Introduction to Ordinary Differential Equations, Wiley, 1980.

4 References:

1. Introduction to Applied Mathematics, Gilbert Strang.

2. E. Kreyszig, Advanced Engineering Mathematics.

5 Similarity with the existing courses: None
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: – All SMSS Faculty

Proposed by: Dr. Muslim Malik **School: SMSS**

Signature: **Date: 06th July, 2023.**

Recommended/Not Recommended, with Comments:

_____ **Date:_____**

Chairperson, CPC

IIT Mandi
Proposal for a New Course

Course number : **IK501**
Course Name : **Yoga Sutras**
Credit Distribution : *(format: 2-0-1-3, (Lectures-Tutorial-Practical-Total credits) replace with relevant numbers)*
Intended for : **Ph.D, Master students, elective for UG students**
Prerequisite : **None**
Mutual Exclusion :

1. Preamble:

India has a great treasure of knowledge and Ashtanga yoga is one of those timeless wisdoms. Yoga treats man as a transcendental spiritual being; it accords the highest position to the inner consciousness and proposes that the physical body is a by-product of the processes in consciousness, not the other way round, as envisioned by modern Scientific and Medical disciplines. Today in many countries, Yoga has gained an image as a system of exercise, physical fitness and calisthenics, totally playing down the core psychological and spiritual transformation that is brought out by following Patanjali's eight-fold framework. In this course students are imparted with this traditional wisdom, not just as a physical exercise program, but for unfolding the latent divinity in the practicing individuals. Practices that enhance the student's personality to lead a harmonious and peaceful existence.

2. Course Modules with quantitative lecture hours: 3 Units = 28 Hours

Unit 1: Philosophy of Yoga (14 Hours)

Unit 1/Topic 1: *Yoga and Yoga Texts* **(Total = 6 Hours)**

1. **Yoga – Basic Introduction**
    a. Meaning and Definition
    b. Importance of Yoga - holistic personality development
    c. Laukik and Adhyatmik benefits of Yoga
    d. Myths and Facts of Yoga
    e. Yoga's Mula Pravakta - Hiranyagarbha
2. **Introduction to Bharatiya Yoga Darshana**
    a. Pathanjali Yogasutras
    b. Sankhya darshana - theoretical concepts

c. Pathanjali Yogasutras - Vyasa Bhashya
d. Yoga siddhanta in Bhagavad-Gita
e. Yoga siddhanta in Upanishads (Katha, Svetashvatara etc)
f. Pauranic Yoga siddhantas (Kapila)
g. Jaina Yoga siddhantas
h. Bauddha Yoga siddhantas
i. Other Yogas - Tantra, Mantra, Laya, Kundalini Yogas

3. **Various paths to Yoga: Jnana, Bhakti, Karma, Ashtanga and Hatha Yoga**
    a. Jnana Yoga - Vivekachudamani, Uddav Gita, Ashtavakra Samhita
    b. Bhakti Yoga - Narada Bhakti Sutras, Shrimad Bhagavatam
    c. Karma Yoga - Bhagavad Gita, Mahabharata
    d. Ashtanga Yoga - Patanjali Yogasutras
    e. Hatha Yoga - Gheranda Samhita, Hatha Yoga Pradipika, Goraksha Samhita
4. **Yoga and Sampradayas**
    a. Nath Sampradaya
    b. Shaiva Sampradaya
    c. Shakta Sampradaya
    d. Vaishnava Sampradaya
    e. Bauddha Sampradaya

Unit 1/Topic 2: *Ashtanga Yoga Sutras* **(4 Hour)**

1. Prasthavana 2.28 and 29
    a. Yama - 2.30
    b. Niyama - 2.32
    c. Asana - 2.46
    d. Pranayama - 2.49
    e. Pratyahara - 2.54
    f. Dharana - 3.1
    g. Dhyana - 3.2
    h. Samadhi - 3.3
2. Dinacharya - Importance and Practice

Unit 1/Topic 3: *Yoga Culture and Value Education* **(4 Hour)**

1. Prominent Streams of Yoga
    a. Jnana Yoga (Discernment)
    b. Bhakti Yoga (Emotional)
    c. Karma Yoga (Kriti)
    d. Raja Yoga (Ashtanga Yoga)
2. Positive and Negative Human Behaviours (Daivi Gunas, Asura Gunas)
    a. Daivi Sampada - Bhagavad Gita - 16.1-3
    b. Asuri Gunas - Bhagavad Gita - 16.4,7,8,9,10,11-18
3. Four Principles Of Jnana Yoga
    a. Viveka
    b. Vairagya
    c. Shat Sampatti
    d. Mumukshutva
4. Relevance of Ancient Indian values in modern life
    a. Purusharthas
    b. Ashrama Vyavastha
    c. Varna Vyavastha - Bhagavad Gita - 14.13
    d. Samskaras

Unit 2: Manas and Sharira - Maintenance and Cleansing (6 Hours)

Unit 2/Topic 1: *Mental and Physical Aspects of the Body*

a. Antahkarana Chatushtaya (Manas, Buddhi, Ahankara, Chitta)
b. Notion of Self and Health and its Metaphysics in Yoga
c. Feelings and Emotional well-being (9 Rasas)
d. Qualities of evolved intellect i.e., Buddhi
e. Well being in Yoga and Ayurveda
f. Impact of positive and negative human tendencies on Psycho-social behavior (Prajnaparadha, Pratipaksha Bhavana, Vitarka Badha)
g. Shoucha Niyamas
h. Balanced Food and Nutrition - Ahara Vihara
i. Maintenance of health through Asana and Pranayama

Unit 3: Applications of Yoga (8 Hours)

Unit 3/Topic 1: *Practical Application of Yoga to Life*

Modern view of Yoga.

Application of principles of Yoga for holistic living.

1. Management Techniques
    a. Application to Career Management
    b. Public speaking and leadership qualities
    c. Workplace wellbeing
    d. Interventions for managing Self and Career
2. Psychology
    e. Concept of Positive Psychology and Stress Management
    f. Managing the five states of Chitta Bhumis (Kshipta, Mudha, Vikshipta, Ekagra, and Nirudha)
    g. Treatment and Counseling of Mentally challenged persons
    h. Prevention of Addiction and Counseling for De-Addiction
3. Application of Yoga in Defense
    i. Application of Upayas (Sama-dana-bheda-dandopayas) using Yoga
    j. Fasting in Yoga (Speech, Food, and Sleep)

Unit 3/Topic 2: *Personality and Family Relationships*

k. Forsaking enmity (Vaira tyaga) and constructive relationships (vishva bandhutva)
l. Techniques for family relationship management (Inclusive temperament, Avoiding Competition, Service attitude)

Laboratory/practical/tutorial Modules: 3 Units (14 Hours)

Unit 1/Topic 2: (4 Hour)

Tutorials: Ashtanga Yoga Sutras, discussion of eight angas with examples, recitation and memorization of important sutras in this context

Tutorials: Yoga for Students (Includes Theory)

1. Surya Namaskaras
2. Basic Pranayama and Kriyas
3. Eyesight improvement
4. Voice Culture
5. Focus and concentration techniques
6. Memory improvement techniques
7. Relaxation technique

Unit 1/Topic 3: (2 Hours)

Practicals

1. Anger management
2. Ego management
3. Time management
4. Removing obstacles in the path of wellbeing

Unit 2/Topic 2: Subtopics **(1 Hour)**

Lec-Dem: Shat karma Shuddhi (Cleansing of Body) Demonstration

1. Neti
2. Dhauti
3. Basti
4. Trataka
5. Nauli
6. Kapalabhati

Unit 2/Topic 3: Subtopics **(2 Hours)**

Tutorials: Yoga Techniques - Demo and Quick Practice

1. Important Vyayamas
2. Pratyahara
3. Dharana
4. Dhyana
5. Samadhi

Unit 3/Topic 3: Subtopics **(5 Hour)**

Practicals: General Yoga Protocol (Children and Youth)

1. Asanas
2. Pranayama
3. Mudra and Bandh
4. Vyayama
5. Sukshma Vyayama

Yoga for Women

Yoga for Elderly

Practicals: Yoga and Positive Psychology

3. Text books:

(Relevant and Latest, Only 2)

1. Patanjali Yog Darshan based on Vyasa Bhashya, by Dr. P. V. Karambelkar, Publishers - Kaivalyadham, Lonavla
2. **Online Resources:** **https://dharmawiki.org/index.php/Category:Yoga**

4. References:

- Hatha Pradipika of Swami Svatmarama, edited by Swami Digambarji and Kokaje, Publishers - Kaivalyadham, Lonavala
- Bhawuk, DPS (2011) Spirituality and Indian psychology. Springer, New York.
- Ranganathananda, S. (2000). Universal message of the Bhagavad Gita.
- Sri Aurobindo. (1942). Essays on the Gita, Vol. 13. Calcutta: Arya Publishing House.
- Swami Anubhavanada, & Kumar, A. (2007). Management with a difference: Insights from ancient Indian wisdom. New Delhi: Ane Books India.
- Swami Bodhananda Saraswati. (1998). Management lessons from Patanjali's yoga sutras. In *Inspirations from Indian wisdom for management*. Ahmedabad Management Association.

- Mind and Self: Patanjali's Yoga Sutra and Modern Science by Subhash Kak, Mount Meru Publishing

Books from Bihar School of Yoga, Munger, Bihar, India

- Hatha Yoga Pradipika by Swami Muktibodhananda, Yoga Publications Trust, Munger, Bihar, India
- Four Chapters on Freedom: Commentary on the Yoga Sutras of Patanjali, by Swami Satyananda Saraswati, Yoga Publications Trust, Munger, Bihar, India
- Gheranda Samhita by Swami Niranjanananda Saraswati, Yoga Publications Trust, Munger, Bihar, India
- Yoga Chudamani Upanishad: Crown Jewel of Yoga by Satyadharma, Swami, Yoga Publications Trust, Munger, Bihar, India
- The Dynamics of Yoga by Swami Satyananda Saraswati, Yoga Publications Trust, Munger, Bihar, India
- Prana and Pranayama by Swami Niranjanananda Saraswati, Yoga Publications Trust, Munger, Bihar, India
- Surya Namaskara by Swami Satyananda Saraswati, Yoga Publications Trust, Munger, Bihar, India

Reference Papers

- Pandey, A and Navare, A.V. (2018) Paths of Yoga: Perspective for Workplace Spirituality. In *The Palgrave handbook of Workplace Spirituality and Fulfilment*. Palgrave Macmillan Cham.
- Pandey A, Gupta RK, Arora AP (2009) Spiritual climate of business organizations and its impact on customers' experience. J Bus Ethics 88(2):313–332.
- Sharma S (1999) Corporate Gita: lessons for management, administration and leadership. J Hum Values 5(2):103–123
- Pandey A, Gupta RK, Kumar P (2016) Spiritual climate and its impact on learning in teams in business organizations. Glob Bus Rev 17(3S).
- Adhia, H., Nagendra, H. R., & Mahadevan, B. (2010). Impact of adoption of yoga way of life on the emotional intelligence of managers. IIMB Management Review, 22(1-2), 32-41.
- Sternberg, R. J. (1993). Intelligence is more than IQ: The practical side of intelligence. Journal of Cooperative Education, 28(2), 6-17.
- Srinivas, K. M. (1994). Organization development: Maya moksha. *Work Motivation Models for Developing Country*. New Delhi: Sage Publications.
- Chakraborty, S. K., & Chakraborty, D. (2008). Spirituality in management - Means or end? Oxford University Press.
- Orme-Johnson, D. W., Zimmerman, E., & Hawkins, M. (1992). Maharishi's vedic psychology: The science of the cosmic psyche. In H. S. R. Kao, & Y. H. Poortinga (Eds.), Asian perspectives on psychology (pp. 282).

5. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: –
Prof. Ganesh Ramakrishnan (IIT Bombay), Dr. Vishwas Pathak

Proposed by: **School: IKSMHA**
Varun Dutt and Arnav Bhavsar
(Local coordinators)

Signature: **Date:**

Recommended/Not Recommended, with Comments:
_____ **Date:**_____
Chairperson, CPC

Approved / Not Approved
_____ **Date:**_____
Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : IK 502
Course Name : **Introduction to Bio-signals**
Credit Distribution : *3-0-2-4*
Intended for : BTech/MTech/MS/MSc/MA/Ph.D.
Prerequisite : None
Mutual Exclusion : None

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1. Preamble:

This course is meant for students interested and working in various types of biological signal measurements including neurological signals and images, cardiac signals, muscular signals etc. The course covers various aspects in the study of biosignals including acquisition, basic signal processing, high-level processing, and applications. This would be serve as a basic but detailed course for students and scholars working in the area of medical signal analysis as well as cognitive science.

2. Course Modules with quantitative lecture hours:

Unit 1: Mathematical Preliminaries: **(3 hours)**
Fourier transform, sampling and filtering, Solution to wave equation in spherical co-ordinate system, Introduction of Spherical Harmonics.

Unit 2: Basics of bio-signals: **(2 hours)**
Definition and models of bio-signals, types of bio-signals, bio-signals monitoring, Pre-processing for bio-signals, bio-signals analysis, and classification of bio-signals.

Unit 3: Brain signals: **(10 hours)**
Human Brain Anatomy, Electroencephalogram (EEG) and magnetoencephalogram (MEG) signals, recording of EEG and MEG signals, EEG signals characteristics and rhythms, evoke potentials, diagnosis of central nervous systems disorders based on brain-signals, various approaches for analysis, feature extraction, and classification of brain signals, MRI and FMRI basics, BOLD signal acquisition, applications of FMRI

Unit 4: Brain Source Localization and connectivity: **(10 hours)**
Array Signal Processing Basics - Data model, correlation and subspace based (MUSIC) localization, Brain Source Localization: Forward & Inverse Problem, Introduction of Head harmonics for brain source localization (BSL), Application of BSL in BCI control, Epileptogenic zone detection. Brain connectivity representation, decomposition methods and types of networks, Clinical and cognitive applications of brain connectivity.

Unit 5: Cardiac signals: **(8 hours)**
Electrocardiogram (ECG) and phonocardiogram (PCG) signals, recording process of ECG and PCG signals, heart rate variability (HRV) signals, diagnosis of heart diseases based on cardiac signals, various methods for analysis, feature extraction, and classification for cardiac signals.

Unit 7: Muscle signals: **(6 hours)**
Electromyogram (EMG) signal, motor unit action potentials (MUAP), EMG and neuro-muscular diseases, feature extraction of EMG, analysis and classification methods for EMG signals.

Unit 8: Other bio-signals: **(3 hours)**
Pulse signals, blood pressure, blood flow, photoplethysmogram, electrooculogram, electroretinogram, center of pressure, and respiratory signals.

Laboratory/practical/tutorial Modules: The course will involve practical assignments which can be conducted in the lab, and would also involve programming assignments.

3. Textbooks:

1. R.M. Rangayyan, Biomedical Signal Analysis: A case Based Approach, IEEE Press, John Willy & Sons. Inc, 2002.

2. Kayvan Najarian and Robert Splinter, Biomedical Signal and Image Processing, Second Edition, CRC Press, 2005.

4. References:

1. M.A. Jatoi and N. Kamel, *Brain source localization using EEG signal analysis*. CRC Press, 2017

2. Boaz Rafaely, Fundamentals of spherical array processing, Berlin: Springer, 2015

3. HL Van Trees, Optimum Array Processing, New York: Wiley, 2002

4. Scott Heuttel, Allen Song, Gregory McCarthy, Functional Magnetic Resonance Imaging (2nd Edition), Sinauer Associates, 2009

5. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	NA			

6. Justification of new course proposal if cumulative similarity content is >30%:

NA

Approvals:

Other Faculty interested in teaching this course: –
Prof. Ram Bilas Pachori (IIT Indore)
Dr. Lalan Kumar (IIT Delhi)

Proposed by: Dr. Arnav Bhavsar
Mental Health Applications Centre

School: Indian Knowledge System and

Signature:

Date: 24th August 2023

Recommended/Not Recommended, with Comments:

_____ **Date:**_____
Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____
Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : IK 503
Course Name : Cognitive Psychology and the Indian Thought System
Credit Distribution : *3-0-0-3*
Intended for : BTech/MTech/MS/MSc/MA/Ph.D.
Prerequisite : None
Mutual Exclusion : None

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1. Preamble:

This course is meant for students working in mental health applications and allied areas to develop awareness on topics concerning cognitive psychology and cognitive neuroscience. These topics may include perception, attention, memory, language, problem solving, reasoning, and judgment and decision-making. This course also brings the Indian thought system perspective from the Samkhya and Yoga, and how the Indian thought contrasts with the western thought. The course will expose students to research methods involving behavioural, neuroimaging, and clinical research from the western theories. This course will provide students an understanding of theories of cognitive psychology involving mental processes for perception, attention, memory, language, problem solving, reasoning, and judgment and decision-making. Also, this course will expose students to the approaches and theories from the Indian thought system. The course may involve lectures, student presentations, discussion, video materials, and class experiments. Students may also work in groups on projects that involve doing experiments to test different theories from the western and Indian thought systems.

2. Course Modules with quantitative lecture hours:

Unit 1: Evolution, Mind, and Brain **(5 Hours)**

Nervous system - anatomy and physiology; Functional neuroanatomy; Tools for investigation – electrophysiology, imaging, and others; how the brain creates mind?; Translation to behavior — emotion/cognition/decision making; mental representations and processing; dissociations and associations.

Unit 2: The Indian Knowledge System **(7 hours)**

Six Schools of philosophy; Buddhism; Bhagavad Gita; Mapping with the Neuroscientific/psychological understanding from Unit 1; Mental health; cognition in Samkhya and yoga; the body – mind – intellect – consciousness complex; consciousness; panca – kosa – a five layered existence; four states of existence; driving issues in

consciousness studies; the tri – guna system; cognitive training hypothesis in yoga; psychological effects of yoga/meditation with clinical and nonclinical populations; Extraordinary cognition hypothesis via eightfold path described in the Yogasutras. Relative versus absolute reality hypothesis.

Unit 3: Perception and Attention **(7 Hours)**

Introduction to perception; visual perception; structure of visual system; top-down (context effects) and bottom-up (from features to objects) processing; visual recognition; interactive nature of perception; nature and roles of attention; failures of selection; successes of selection; information processing theories of attention; electrophysiology and human attention; functional neuroimaging and transcranial magnetic stimulation.

Unit 4: Representation, Encoding, and Retrieval of Knowledge in Long-Term Memory **(7 Hours)**

Role of knowledge in cognition; representations and their formats; representation to category knowledge; structures in category knowledge; category domains and organization; nature of long-term memories; encoding; retrieval; encoding with difficulty to recall; non-declarative memory systems.

Unit 5: Working Memory and Executive Processes **(6 Hours)**

Introduction to working memory; from primary memory to working memory; working memory models; person-to-person variation; dopamine's role; frontal lobe connection; frontal damage and the frontal hypothesis; executive attention; switching attention; inhibition of response; sequencing; monitoring.

Unit 6: Emotion, Cognition, Decision-making, and Problem Solving **(7 Hours)**

Defining emotion; manipulating and measuring emotion; emotional learning: acquiring evaluations; emotion and declarative memory; emotion, attention, and perception; nature of a decision; rational decision making; neural bases of expected utility calculations; human decision making and the expected utility model; complex, uncertain decision making; nature of problem solving; analogical reasoning; inductive reasoning; deductive reasoning.

Unit 7: Language, Motor Cognition, and Mental Simulation **(5 Hours)**

Nature of language; processes of language comprehension; processes of language production; language, thought, and bilingualism; nature of motor cognition; mental simulation and the motor system; imitation; biological motion.

Laboratory/practical/tutorial Modules: None.

3. Textbooks:

Smith, E. E., & Kosslyn, S. M. (2013). *Cognitive Psychology. Mind and Brain.* New Jersey: Pearson. ISBN: 978-1-292-02235-2

Eysenck, M. W., & Keane, M. T. (2020). *Cognitive Psychology, A Student's Handbook* (Eighth Edition). Hove: Psychology Press. ISBN: 1-84169-359-6

4. References:

Ward, J. (2015). *The Student's Guide to Cognitive Neuroscience* (3rd edition). Hove: Psychology Press. ISBN: 1841695343

Anderson, J. R. (2020). *Cognitive Psychology and Its Implications* (9th edition). Worth Publishers. ISBN: 1319067115

Sedlmeier P. & Srinivas K. (2016). How Do Theories of Cognition and Consciousness in Ancient Indian Thought Systems Relate to Current Western Theorizing and Research? *Front Psychol*. 2016 Mar 15;7:343. doi: 10.3389/fpsyg.2016.00343.

5. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	NA			

6. Justification of new course proposal if cumulative similarity content is >30%:

NA

Approvals:

Other Faculty interested in teaching this course: – Dr. Alok Bajpai

Proposed by: Dr. Varun Dutt
Mental Health Applications Centre

School: Indian Knowledge System and

Signature:

Date: 24th August 2023

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : MA-528
Course Name : Measure Theory and Integration
Credit Distribution : (3-1-0-4)
Intended for : M.Sc./M.S./PhD/B.Tech
Prerequisite : MA-511 (Real Analysis)
Mutual Exclusion : NA

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1. Preamble:

This one semester course is designed to provide exposure of the concept of measure theory and to teach the students how integration can be developed in terms of measure. The course starts with a review of Riemann integral, which is defined on a closed and bounded subset of $\mathbb{R}$. The main idea of Lebesgue integration is to generalize the concept of Riemann integration and to formulate an abstract notion of integration. We will define the essential L^p spaces which are frequently used in Harmonic analysis and Partial differential equation. In this course we will cover all the basic topics: Properties of Lebesgue Integral, Lebesgue Dominated Convergence Theorem, Fundamental Theorem of Calculus, Radon-Nikodym Theorem, Fubini's Theorem and so on.
Apart from measure theory has central importance in pure mathematics, it has also uses in different branches of applied mathematics as well in Fourier analysis, Probability theory etc.

2. Course Modules with quantitative lecture hours:

Module 1: Review of Riemann integral, Algebra of subsets of a non-empty set, Measure on an arbitrary sigma-algebra, Continuity property of measure, The induced outer measure, Measurable sets, Borel Sigma algebra, Monotone class, Completion of a measure space , The Lebesgue measure on $\mathbb{R}$, Properties of Lebesgue measure, Non measurable subsets of $\mathbb{R}$.

(14 hours)

Module 2: Simple measurable functions, Integral of non-negative measurable functions, Monotone convergence theorem, Fatou's Lemma, Dominated convergence theorem, Relation between Riemann , Improper and Lebesgue integrals , Riesz-Fischer theorem (L_1[a,b] is a complete metric space) , R[a,b] is dense L_1[a,b], Lusin's theorem, Lp- spaces, Convergence of measurable functions (almost everywhere , in measure, in mean).

(16 Hours)

Module 3: Absolutely continuous functions, Differentiability of monotone functions (Only statement of Lebesgue-Young theorem), Fundamental theorem of calculus for Lebesgue integrable functions, Radon-Nikodym theorem, Product measure, Fubini's theorem, Signed measure, Riesz representation theorem (Without proof) .

(12 Hours)

3. Text books:

1. I. K. Rana, An introduction to Measure and Integration, Second Edition, Narosa, 2005.
2. G. de Barra, Measure and Integration, Wiley Eastern, 1981.

4. References:

1. W. Rudin, Real and Complex Analysis, Third edition, McGraw-Hill, International Editions, 1987.
2. H. L. Royden, Real Analysis, Third edition, Prentice-Hall of India, 1985.
3. G. B. Folland, "Real Analysis", Wiley-Interscience Publication, John Wiley & Sons, 1999.
4. M. Thamban Nair, Measure and Integration, A first course, CRC Press, 2020.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course code	Similarity content	Approx.% of content
1.	Riemann integration	MA-511	2 hours	~4.76%
2.	Measurable space	MA-524	1 hour	~2.38%

Approvals:

Other Faculty interested in teaching this course: – Dr. Qaiser Jahan

Proposed by: Dr. Saswata Adhikari **School: School of Basic Sciences**

Signature: **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : MA-529
Course Name : Statistical Inference
Credit Distribution : 3-1-0-4
Intended for : M.Sc./M.S./PhD/ B.Tech
Prerequisite : MA-524 (Probability and Statistics)
Mutual Exclusion : NA

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1. Preamble:

In this one semester course, we will review the basic concepts of statistical inference. The course aims at providing in-depth understanding about the theory of estimation and testing of hypotheses. Statistical inference is about analyzing and drawing conclusions from the data. In particular, we will focus on the so-called parametric model. We will assume that the data is from certain family of distributions (e.g., a Normal distribution) and the goal is to make inference about the underlying unknown parameter/s (e.g., the mean and/or variance of Normal) using the data. For a parametric model, there are three common tasks in statistical inference – estimating the underlying parameter/s, providing a confidence interval for the underlying parameter/s, and testing if the underlying parameter/s satisfy certain conditions. In parametric inference, there are two major approaches – the frequentist approach and the Bayesian approach. Concepts of both the theoretical set-ups will be discussed and practical problems will be discussed in detail. This course will serve as a foundation course for students working on Machine Learning. Candidates need to have a general knowledge of probability, data collection, and descriptive statistics to understand the content without any difficulty.

2. Course Modules with quantitative lecture hours:

Module 1: Random sample, Statistics, Order statistics, Sampling distributions, Parametric point estimation, Estimator, Unbiasedness, Sufficiency, Minimal sufficiency, Factorization theorem, Rao-Blackwell theorem, Completeness, Lehmann-Scheffe theorem, UMVUE, Basu's Theorem, Lower bounds for the variance of an estimator, Frechet-Rao-Cramer, Bhattacharya, Chapman- Robbins-Keifer inequalities.

(16 Hours)

Module 2: Consistency, Efficiency, Method of moments and method of maximum likelihood, Bayes estimators and Minimax Procedure, Invariance, Best equivariant estimators.

(10 Hours)

Module 3: Tests of hypothesis, Simple and composite hypothesis, Types of error, Neyman-Pearson Lemma, Families with monotone likelihood ratio, UMP, UMP unbiased and UMP invariant tests, Likelihood ratio tests- applications to one sample and two sample problems, Chi-square tests, Bayes tests, Methods for finding confidence intervals, shortest length confidence intervals, Bayesian confidence interval.

(16 Hours)

3. Text books:

1. Main Text Book: Statistical Inference, George Casella and Roger L. Berger, Duxbury Press, second edition 2001.
2. An Introduction to Probability and Statistics, Vijay K Rohatgi and A. K. Md. Ehsanes Saleh, John Wiley, second edition, 2001.

4. References:

1. A. M. Mood, F. A. Graybill and D. C. Boes, Introduction to the theory of Statistics, McGraw Hill Education, 3rd edition (2017)
2. J. Shao, Mathematical Statistics, Springer, (1998).
3. E. L. Lehmann, G. Casella, Theory of Point Estimation, Springer, (2006).
4. E. L. Lehmann, J. P. Romano, Testing of Statistical Hypothesis, Springer, (2006)

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course code	Similarity content	Approx.% of content
1.	Interval estimation + Testing of hypothesis	MA-524	2 hours	~4.76%

Approvals:

Other Faculty interested in teaching this course: – Dr. Sarita Azad

Proposed by: Dr. Deepak Prajapati **School: School of Basic Sciences**

Signature: **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : **MA 530**
Course Name : **Graph Theory**
Credit Distribution : **L-T-P-C:(3-1-0-4)**
Intended for : **UG/PG**
Prerequisite : **Basic understanding of mathematics**
Mutual Exclusion : **None**

1. Preamble:

This is a basic course on Graph Theory. The main objective of this course is to introduce the basic concepts of Graph Theory. It is a field that has great importance in mathematics and has tremendous applications in various fields of Science and Technology, like applications to Engineering, Computer Sciences, Network analysis, etc. This course will provide the students an opportunity to learn the fundamental concepts of Graph Theory.

2. Course Modules with quantitative lecture hours:

1. **Basics:** Graphs, subgraphs, isomorphism, representation of graphs, degrees, walks, trails, paths, cycles, bipartite graphs. **[5 Hours]**
2. **Trees and connectivity:** Characterizations of trees, minimum-spanning-trees, number of trees, Cayley's formula, shortest path algorithms. **[5 Hours]**
3. **Eulerian and Hamiltonian graphs:** Characterizations, Necessary/sufficient conditions. **[4 Hours]**
4. **Graph Coloring:** vertex coloring, chromatic polynomials, edge coloring. **[4 Hours]**
5. **Planar graphs:** Properties, Euler's formula and its consequences, Kuratowski's Characterization. **[6 Hours]**
6. **Matching and Factorizations:** matching in bipartite graphs, maximum matching in general graphs, Hall's marriage theorem, factorization; Tutte's perfect matching theorem and consequences. **[7 Hours]**
7. **Networks:** The Max-flow min-cut theorem, connectivity and edge connectivity,

Menger's theorem. **[6 Hours]**

8. **Graph and Matrices:** Adjacency matrix, Laplacian matrix, Eigen Values. **[5 Hours]**

1. Text books:

1. J. A. Bondy and U.S.R Murthy, *Graph Theory with Applications*, Macmillan, 1976.
2. D. B. West, *Introduction to Graph Theory*, Vol:2, Prentice hall, 2001.

2. **References:**

1. F. Harary, *Graph Theory,* Addison-Wesley publishing company, 1969.
2. R. Diestel, *Graph Theory*, 3rd ed. Graduate texts in mathematics 173, 2005.
3. R. B. Bapat, *Graphs and Matrices*, Vol. 27. London: Springer, 2010.

1. Similarity with the existing courses: No

(Similarity content is declared as per the number of lecture hours on similar topics)

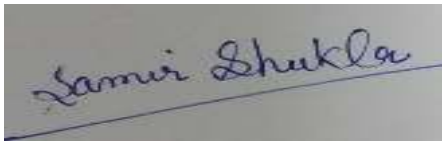
S. No.		Course Code	Similarity Content	Approx. % of Content

6. Justification of new course proposal if cumulative similarity content is >30%:

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: Dr. Samir Shukla **School:** SMSS



IIT Mandi
Proposal for a New Course

Course number	**: Mathematical Modeling**
Course Name	**: MA 610**
Credit Distribution	**:** 3-0-0-3
Intended for	**:** Elective for M.Sc./ MTech/PhD/BTech (All Branches)
Prerequisite	**:** IC 110, IC 111 for BTech, Ordinary Differential Equations for M.Sc./MTech/PhD
Mutual Exclusion	**: NA**

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1. Preamble:

The objective of this course is to introduce the use of mathematics as an effective tool in solving real- world problems through mathematical modelling and analytical and/or numerical computations. By using examples in physical, engineering, biological and social sciences, we show how to convert real-world problems into mathematical equations through proper assumptions and physical laws. Qualitative analysis and analytical solutions for some models will be provided to interpret and explain qualitative and quantitative phenomena of the real-world problems.

2. Course Modules with quantitative lecture hours:

Module 1: Introduction -Aim and history, A few simple examples, what is a model, The process of mathematical modeling, Model classification

(4 hours)

Module 2: Optimization models - One variable optimization, some additional materials on population, Multi variable optimization, Computational methods for optimization, some materials on simplex method, Discrete Models - World population growth data snooping, Linear models, Logistic models, Theorems on stability

(7 hours)

Module 3: Probability models-Introduction, Discrete probability models, Continuous probability models, Models for population, Introduction of Population models: Malthus model, Population growth: Logistic model, Harvesting, Population of interacting species: Lotka-Volterra systems (some additional materials), Age-dependent population models.

(7 hours)

Module 4: Applications of mathematical modeling-Mainly mathematical models to study and understand phenomena in chemistry, biology , engineering, political sciences, business and in social sciences.

(6)

Laboratory/practical/tutorial Modules:

Individual final project: During the last two weeks of the semester, each student will carry out a project investigating a new mathematical model or carrying out a significant extension of an existing mathematical model discussed in class

(6)

Textbooks:

1. A First Course in Mathematical Modeling (4th edition), 2009, by F. R. Giordano, W. P. Fox, S. B. Horton and M. D. Weir. Publisher: Brooks/Cole Publishing Company (ISBN-10: 049555877X; ISBN-13: 9780495558774).
2. Mathematical Modelling: A Tool for Problem Solving in Engineering, Physical, Biological and Social Sciences, Pergamon 1990.

References:

1. Mathematical modeling: a tool for problem solving in engineering, physical, biological, and social sciences, 1990, by D.N.P. Murthy and N.W. Page and E.Y. Rodin. Publisher: Pergamon Press.
2. Mathematical modeling: a case study approach, 1989, by Dick Clements. Publisher: Cambridge University Press.
3. Modeling with Ordinary Differential Equations, 1993, by T.P. Dreyer. Publisher: CRC Press.
4. Clive L. Dyne: Principles of Mathematical Modelling, Academic Press, 2004.
5. Mathematical Modeling (second edition), 1998, by M. M. Meerschaert. Publisher: Academic Press

3. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	ME620	Nil	Nil
2.	BE506	Nil	Nil
3.	MA650	Deterministic models	<5%

6. Justification of new course proposal if cumulative similarity content is >30%: NA

Approvals:

Other Faculty interested in teaching this course: – Not known

Proposed by: Dr. Nitu Kumari **School: SBS**

Signature: Nitu **Date: Initially Proposed in May, 2022**

Recommended/Not Recommended, with Comments:

_____ Date:_____

Chairperson, CPC

Approved / Not Approved

_____ Date:_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number	**:** MA-611
Course Name	**:** Statistical tools and Computing
Credit Distribution	**:** 3-1-0-4
Intended for	**:** M.Sc. /M.S./PhD/ B.Tech. 3rd and 4th year.
Prerequisite	**:** MA-524 (Probability and Statistics) or any course on probability and statistics (like Data Science II) in consultation with the instructor.
Mutual Exclusion	**:** HS550

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1. Preamble:

As the scale and scope of data collection continue to increase across virtually all fields, statistical learning has become a critical toolkit for anyone who wishes to understand data. This course on Statistical tools and Computing provides a comprehensive elucidation of key topics in statistical learning. Each module includes a lab component and will involve theoretical topics and programming assignments. The course introduces data analysis as a means of modelling measurements made over an interval of time and space. The course is useful for anyone who wishes to use contemporary tools for data analysis.

2. Course Modules with quantitative lecture hours:

Module 1- Concepts from probability and statistics:
Data (sample vs. Population, histograms, sample mean, median, variance, standard deviation); Probability (axioms, basic rules; and conditional probability); Random variables (discrete vs. Continuous); Review of probability distributions. Some advanced probability distributions: their properties and simulations; Confidence intervals and their significance.

(8 Hours)

Module 2 -Times series methods:
Collection and classification of data; Different types of diagrams to represent statistical data; Frequency distribution and related graphs and charts; Linear and non-linear models.

(6 hour)

Module 3 -Regression, classification and multivariate analysis
Simple regression; Multiple regression; Logistic regression; Generalized linear models; Cross validation; Multicollinearity; Model selection; Prediction and variable selection; Bayesian logistic regression; Principal component analysis; Factors analysis; Discriminant and Classification analysis.

(13 Hours)

Module 4: Parametric and Nonparametric tests:

Parametric: *Parametric tests* are used only where a normal distribution is assumed. The most widely used tests are the t-test (paired or unpaired); ANOVA (one-way non-repeated, repeated), and Pearson rank correlation.

Nonparametric: *Non-parametric tests* are used when continuous data are not normally distributed or when dealing with discrete variables. Most widely tests used are Chi-squared; Fisher's exact tests; Wilcoxon's matched pairs; Mann–Whitney U-tests; Kruskal–Wallis tests and Spearman rank correlation; Bayesian inference; Kernel Density Estimation.

(15 Hours)

Laboratory/practical/tutorial Modules:

The labs, using programming languages like R/Python/any other, will take place over a two-hour period in alternate weeks. It will run concurrently with the theory course, thus the subjects for the lab will have previously been established in the theory session.

3. Text books:

1. An Introduction to Statistical Learning, with Applications in R (second edition) by James, Witten, Hastie and Tibshirani (Springer, 2021)
2. Introduction to Applied Statistics: A non-Calculus Based Approach by David D. Hanagal (Narosa, 2009)

3. References:

1. Introduction to Statistics by David Lane, Rice University (David Lane, 2003)
2. Introduction to Statistics and Data Analysis by Jay Devore, Roxy Peck, Chris Olsen Third edition (Wadsworth Publishing, 2008)
3. Generalized linear models with examples in R by Peter K. Dunn, Gordon K. Smyth (Springer, 2018)

4. Similarity with the existing courses:

S. No.	Course code and Title	Similarity content	Approx.% of content
1.	MA-524 Probability and Statistics	Introduction to probability, regression, descriptive statistics	~10-15%
2.	MA 605 Statistical data	Regression, classification descriptive statistics	~10-15%

	analysis		
3.	DS403 Introduction to Statistical Learning	Regression	~5%
4.	HS550	Concepts like probability, regression.	~15-20%

6. Justification of new course proposal if cumulative similarity content is >30%: NA

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: **School:**

Signature: **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

Proposal for New Course		
Course Number	**:**	MB510
Course Name	**:**	Probability and Statistics for Data Science and AI
Credits	**:**	2-0-0-2 (L-T-P-C)[1]
Prerequisites	**:**	None
Intended for	**:**	MBA
Distribution	**:**	Compulsory
Semester	**:**	Odd

Preamble

Increasingly more acceptability of data science and artificial intelligence (DSAI) in industry urges for proper explanation of the working of complex DSAI tools and techniques. The explainability of AI models requires sound statistics and probability knowledge. Also, todays businesses are becoming more complex and complicated. The AI techniques as a solution to this complex and complicated business requires proper understanding of associated uncertainty and risk. Statistics and probability theories are used to deal with these uncertainties and risks. Growing availability of data and pressure on using these data for decision making is an industrial norm. So, it is paramount to use well developed theories of statistics and probability to make sense of data. This course is focusing on understanding the basic concepts of probability and statistics to gain a mastery over the discipline of data science and artificial intelligence.

Objective

On completion of this course, the student should be able to:

- understand intuitively the complex concepts of statistics and probability.
- interpret and apply these concepts in real-life business problem solving and decision making.
- appreciate the intimate link between business and mathematics in general.

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

Course Modules with Quantitative lecture hours		
Module 1	**Introduction**	**(4)**
Uncertainty and probability, Probability and its types, Conditional, joint and marginal probability, Problem classification with emphasis on random problems, Probability and statistics concepts for DSAI.		
Module 2	**Random Variables and Probability Distributions**	**(4)**
Describing Randomness, Random Variables and Probability Distributions- Continuous and Discrete Distributions, Normal distribution, lognormal distribution and Power-Law Distributions, Bernoulli distributions.		
Module 3	**Statistics**	**(4)**
Collections of Random Values-Expected Value, variance and standard deviation, Independent and Identically Distributed Variables, law of large numbers, central limit theorem.		
Module 4	**Sampling**	**(4)**
Sampling and Replacement-Selection with Replacement, Selection Without Replacement, Bootstrapping.		
Module 5	**Bivariate Statistics**	**(4)**
Covariance and Correlation-Pearson and Spearman.		
Module 6	**Baye's Rule**	**(4)**
Frequentist vs. Bayesian Probability, Bays Rule and Confusion Matrices, Repeating Bayes' Rule, Multiple Hypothesis.		
Module 7	**Information Theory**	**(4)**
Entropy, Measuring uncertainty, information, and surprise, Maximal entropy distribution, Cross Entropy, KL Divergence		

Lab Exercises (If applicable):
Nil

Textbooks:	
1.	Nil
2.	
Reference Book:	
1.	Thomas Nield (2022), Essential Math for Data Science: Take Control of Your Data with Fundamental Linear Algebra, Probability, and Statistics, Shroff Publishers & Distributors Pvt. Ltd., Mumbai
2.	Trevor Hastie, Robert Tibshirani, Jerome Friedman (2017), The Elements of Statistical Learning: Data Mining, Inference, And Prediction, Springer (2nd ed.)
3	Anirban Das Gupta (2011), Probability for Statistics and Machine Learning: Fundamentals and Advanced Topics, Springer
4	Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong (2020), Mathematics for Machine Learning, Cambridge University Press (https://mml-book.com)
5	Scott E. Page (2018), The Model Thinker: What You Need to Know to Make Data Work for You, Basic Books.
6	MS Excel 2019 (2020), Data Analysis & Business Modeling, Wayne Winston, Microsoft Press (PHI).

Proposal for New Course		
Course Number	**:**	MB511
Course Name	**:**	Python Programming
Credits	**:**	2-0-0-2 (L-T-P-C)[1]
Prerequisites	**:**	Preferably having sound knowledge in programming
Intended for	**:**	MBA
Distribution	**:**	Compulsory
Semester	**:**	Even

Preamble
This course helps a motivated student with little or no prior programming experience with working knowledge of the Python programming language for the purpose of data analytics. These skills are foundational for anyone interested in a career in data science. This course is very essential for every manager in today's data-rich economy. Python is one of the world's most popular programming languages due to its simplicity, versatility, efficiency, and community support. Recent surveys have found it to be the most highly demanded programming language among job postings in data science. More importantly than covering the technical tools, this course focuses on how to apply the tools for business applications.

Objective
Upon successful completion of the course, students will be able to: ● Predict the result of a given piece of Python code. ● Write Python code to read, write, filter, merge, summarize, and draw graph in a given dataset. ● Analyse data from a variety of domains and uncover business insights.

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

- Communicate effectively the purpose, methodology, and result of an analysis involving Python to a non-technical business audience.

Course Modules with Quantitative lecture hours		
Module 1	**Basics of Programming**	**(5 hours)**
This module presents a primer on the building blocks of a program and how to logically sequence the components to perform a complex task. The following topics will be covered: 1. Introduction to Programming 2. Variables, Statements and Conditional Execution 3. Functions 4. Iterations		
Module 2	Data Structures	**(8 hours)**
This module introduces the fundamental data structures in Python and Panda. This module helps the students to learn "How should data be stored in a particular business setting and what are the trade-offs involved?". The following topics will be covered: 1. Strings and Files 2. Lists and Dictionaries 3. Pandas DataFrame Basics 4. Pandas Data Structure		
Module 3	Basic Analysis	**(8 hours)**
This module introduces the basic techniques in Pandas for plotting, assembling, and handling missing data. The following topics will be covered: 1. Introduction to Plotting 2. Data Assembly 3. Missing Data		
Module 4	Data Munging	**(7 hours)**
Data munging, also known as data wrangling, is the process of transforming raw data into another		

format with the intent of making it more appropriate for analysis. It is one of the very important steps in data analysis. The following topics will be covered:

1. Tidy Data and Data Types
2. Text Data
3. Pandas Apply and Group-by Operations

Lab Exercises (If applicable):

Lab to be conducted on a 2-hour slot. It will be conducted in tandem with the theory course so the topics for problems given in the lab are already initiated in the theory class. The topics taught in the theory course should appropriately be sequenced for synchronization with the laboratory.

Textbooks:	
1.	Charles R. Severance. *Python for Everybody: Exploring Data in Python 3,* Amazon Digital Services, 2016, ISBN-13 : 978-1530051120
2.	Daniel Y. Chen. *Pandas for Everyone: Python Data Analysis*, Pearson Education, 2018, ISBN-13 : 978-9352869169
Reference Book:	
1.	Michael Dawson. Python Programming for the Absolute Beginners, Cengage, 2020.

Proposal for New Course		
Course Number	**:**	MB512
Course Name	**:**	Mathematical Foundations for DS and AI
Credits	**:**	2-0-0-2 (L-T-P-C)[1]
Prerequisites	**:**	None
Intended for	**:**	MBA
Distribution	**:**	Compulsory
Semester	**:**	Q1-Semester 1

Preamble

Mathematics is said to be the queen of sciences and so without mathematics the evolving field of data science and artificial intelligence (DSAI) will remain quite incomplete. The DSAI is increasingly involved in making important decisions in the modern era industry and society. Further, this field is becoming an integral part of our live and directly or indirectly influencing multiple aspects of it.

To understand this complex and rapidly changing field of DSAI, this course is focused on all basic mathematical concepts like vectors, matrices, dimensions, calculus and optimization. These mathematical understanding is essential in understanding data-driven decision making that makes use of advanced analytics. This course is emphasizing on understanding of the most useful mathematical concepts for DSAI implementation. Additionally, this is also ascertained here that one need not be an expert in this topic in order to succeed in the field of DSAI. Rather, one need to have a deeper understanding of certain useful topics drawn from the big gamut of mathematical field.

Objective

On completion of this course, the student should be able to:

- understand mathematical concepts more intuitively.
- visualize applications of math in DSAI-based problem solving and decision making.
- comprehend the link between mathematics and business.
- appreciate the use of complex mathematical concepts to handle business scenarios.
- Transform and visualize business problems in mathematical form.

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

Course Modules with Quantitative lecture hours		
Module 1	**Introduction**	**(2 hours)**
Why mathematics for machine learning and artificial intelligence, concepts of models; constants, parameters and variables; mathematical models, simple and deterministic models.		
Module 2	**Linear Algebra**	**(8 hours)**
Linear equations and solutions, Scalars and Vectors, vector arithmetic and operations, orthogonality; Linear Independence, basis vectors; Matrices, basic matrix arithmetic and operations, rank of a matrix, matrix types, sparse matrix, matrix factorization, soft introduction to concepts of Tensors; Concepts of linearity and nonlinearity, linear Mappings, Vector and matrix norms; Eigenvectors and eigenvalues, singular value decomposition (SVD).		
Module 3	**Calculus**	**(6 hours)**
Limits and Functions, nature of Functions, univariate and multivariate functions, continuity of a function; basic functions like exponential, logarithmic, trigonometric, hyperbolic, modulus, greatest integer etc; squashing functions and activation functions; composite functions, Derivative, derivative of basic functions and activation functions, Chain rule, concepts of partial differentiation; Integrals, substitution rule, areas between curves.		
Module 4	**Dimensions**	**(4 hours)**
Concepts of dimensions-zero dimension to multiple dimensions, hyperspace, Euclidean space and dimensions, Euclidean distance between points, soft introduction to non-Euclidean space; vectors and matrices in dimensional space; Dimensions and analysis space; Business concepts and dimensions, mapping business problems into dimensional representation, multidimensional analysis.		
Module 5	**Optimization**	**(8 hours)**
Concepts of single and multiple attributes, objectives and criteria; Concepts of constraints and constraint satisfaction problems; Maximum and minimum of univariate and multivariate functions, Saddle Points, local and global optimum, concepts of linear and nonlinear optimization, constrained and unconstrained optimization, soft introduction to linear programming; search space, feasible and infeasible solution space, single agent and multi-agent search problems, search domain exploration and exploitation; Least squares method, Concept of gradient, gradient of vector valued functions, gradient of matrices; loss functions, gradient descent method.		

Lab Exercises (If applicable):
Nil

Textbooks:	
1.	Nil
2.	
Reference Book:	
1.	Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong (2020), Mathematics for Machine Learning, Cambridge University Press (https://mml-book.com)
2.	Thomas Nield (2022), Essential Math for Data Science: Take Control of Your Data with Fundamental Linear Algebra, Probability, and Statistics, Shroff Publishers & Distributors Pvt. Ltd., Mumbai
3.	Charu C. Aggarwal (2020), Linear Algebra and Optimization for Machine Learning, Springer Nature Switzerland AG.
4	MS Excel 2019 (2020), Data Analysis & Business Modeling, Wayne Winston, Microsoft Press (PHI).

Proposal for New Course		
Course Number	**:**	MB513
Course Name	**:**	Principles of Management
Credits	**:**	2-2 (L-T-P-C)[1]
Prerequisites	**:**	None
Intended for	**:**	MBA
Distribution	**:**	Compulsory
Semester	**:**	

Preamble
Understanding the discipline of management and its evolution is very important. Generally, management as a function to get things done. It broadly involves planning, organising, directing, staffing, coordinating and leadership. The subject also involves understanding skills and functions of a manager and leader.

Objective
The course objectives are: - Understand management as a concept, process, and function. - Develop decision-making abilities for designing and executing management plans and strategies

Course Modules with Quantitative lecture hours		
Module 1	**Introduction to Management**	**6**
Definition, Nature, Scope, Purpose, and characteristics, Functions, roles, skills of a Manager, Theories in management - Classical, Scientific, Systems, Contingency and		

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

operational. Management Vs Administration, Bureaucracy, Decision Making – Types, components, process and creative decision making.		
Module 2	**Planning and Forecasting**	**6**
Planning – Types, Process, MBO – Concept, Characteristics, process, benefits and limitations, Strategic management – Environment Scanning, Industry Analysis, Resource Based View, Forecasting – Nature, components, determinants, benefits, and techniques..		
Module 3	**Organising and Directing**	**4**
Organisational Design, types and structure, Organisational Hierarchical systems, formal and informal organisation, centralisation and decentralisation, span of control, authority and responsibility, delegation, culture and performance metrics		
Module 4	**Staffing and Coordination**	**6**
HRM and HRD, Workforce Diversity, Coordination - Need, Importance, Principles, Process, Types, and Techniques, conflicts, conflict resolution, negotiations, communication in workplace		
Module 5	**Leadership and Change**	**4**
Leadership - Concept, Nature, Importance, Attribute, and Style. Change – Concept, Nature, Importance, Causes. Learning Organisation. Ethics, CSR		

Textbooks:	
1.	Fundamentals of Management – Stephen Robbins, and David Decenzo
2.	Essentials of Management – Harold Koontz, Odonnell and Heinz Welhrich
Reference Book:	
1.	Principles of Management by Richard Daft.
2.	

Proposal for New Course		
Course Number	**:**	MB514
Course Name	**:**	Communication Skills for Managers
Credits	**:**	2-0-0-2 (L-T-P-C)[1]
Prerequisites	**:**	None
Intended for	**:**	MBA
Distribution	**:**	Compulsory
Semester	**:**	Even/Odd

Preamble

This course will equip students with essential skills of managerial communication. This course focuses on ensuring that students become effective communicators in a managerial context by learning to apply concepts of strategic communication. Students will learn concepts of effective communication and the application of those concepts through case studies and role-plays. Through a blend of theory and practice, students will be able to improve their communication skills and orient themselves better to contemporary industry expectations.

Objective

This course is a blend of theory and practice. It seeks to equip students with concepts of effective communication and their applications in managerial contexts.

On completion of this course, the student should be able to:

- Communicate effectively and persuasively
- Develop and deliver effective presentations
- Understand concepts of managerial communication
- Improve verbal and non-verbal communication

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

Course Modules with Quantitative lecture hours		
Module 1	**Best Practices for Effective Communication**	**(6 hours)**
This Module introduces the basic concepts of effective communication. These will include foundations of organizational communication; communication barriers and ways to overcome them; speaking and listening skills; audience centric communication framework. The objective of this module is to introduce the concepts of effective communication to the students and equipping them with strategies to craft clear and concise messages.		
Module 2	**Persuasion and Influence**	**(6 hours)**
This Module introduces persuasive communication strategies to students. This will be an inter-disciplinary module, with theories from rhetoric, strategy and negotiation informing the content. Frameworks include the Aristotelean persuasive framework, Toulmin's Method of argumentation and storytelling strategies. The application of these theories will be illustrated through appropriate case studies.		
Module 3	**Public Speaking and Presentation Skills**	**(8+4 hours)**
The third Module will focus on effective presentation preparation and delivery. For preparing presentations, students will learn how to craft a perfect blend of data and narrative through design, structuring of content, using multimedia, and storytelling techniques. This module will also include aspects of effective non-verbal communication, managing questions, framing presentations, using gestures and postures, and public speaking skills. Students will be required to prepare and deliver group presentations as a part of this module.		
Module 4	**Workshop on Interview Skills**	**(4 hours)**
The final module of this course will equip students with communication skills and strategies for cracking interviews. This module will be delivered in workshop mode, with role-plays and feedback		

sessions with the students. Topics covered in this module include cross-cultural communication, understanding industry narratives, techniques of articulation and frameworks for handling questions

Textbooks:	
1.	Bovee, Courtland L., John V. Thill and Roshan Lal Raina. Business Communication Today. Tenth Edition. Delhi: Pearson, India, 2018.
2.	
3.	
4.	
Reference Book:	
1.	Morgan, N., Cialdini, R. B., Review, H. B., Tannen, D. (2013). HBR's 10 Must Reads on Communication (with Featured Article "The Necessary Art of Persuasion," by Jay A. Conger). United States: Harvard Business Review Press.
2.	
3.	

Case Studies:

1. Super Bowl Storytelling (Shelle Santana, Jill Avery)
   Link: https://hbsp.harvard.edu/product/519041-PDF-ENG?Ntt=super%20bowl

2. A Persuasion Strategy for Universita' Bocconi: An Exercise (Giovanni Gavetti)
   Link: https://hbsp.harvard.edu/product/711517-PDF-ENG?activeTab=include-materials&itemFindingMethod=#educator-copy

3. Managing Up (A): Grace (Karen MacMillan)
   Link: https://hbsp.harvard.edu/product/W15269-PDF-ENG?Ntt=managing%20up%20grace

Proposal for New Course		
Course Number	**:**	MB515
Course Name	**:**	Financial Statements Analysis
Credits	**:**	2-0-0-2 (L-T-P-C)[1]
Prerequisites	**:**	None
Intended for	**:**	MBA
Distribution	**:**	Compulsory
Semester	**:**	Even

Preamble
Financial Statements Analysis (FSA) course helps post-graduate students in understanding the structure, line items, accounting principles and analysis of financial statements. Using managerial approach of learning, the course will be taught with the help of financial statements published in annual reports of companies. The main outcome of this course is to make the students intelligent users of financial statements for improved credit decisions, investment decisions and managerial decisions.

Objective
Using the balance sheet, statement of profit and loss and cash flows statement from an annual report of a company, students would understand basics of how to make these statements under managerial approach and understand analysis of financial statements from the perspective of credit decision, investment decision and forensic. On completion of this course, the student should be able to: - make financial statements under managerial approach, - get conversant with accounting records, - understand various methods of measurement of depreciation and inventory, - visualize the impact of different methods of measurement on financial statements, and - analyse financial statements using various techniques.

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

Course Modules with Quantitative lecture hours		
Module 1	**Balance Sheet**	**(4 hours)**
This module begins with brief introduction to the course, financial statements, and users of financial statements. The balance sheet module helps students in understanding the line items, accounting principles, construction, and analysis of balance sheet. At the end of this module, students should be able to understand the major sources of funds which are in the form of liabilities and equity and understand major application of funds which are in different forms of assets of a company reading its balance sheet. The students also should be able to make the balance sheet using double entry principle of accounting.		
Module 2	**Statement of Profit and Loss**	**(4 hours)**
This module helps students in understanding the line items, accounting principles, construction, and analysis of statement of profit and loss. At the end of this module, students should be able to understand major sources of revenue, major expenses, and various terms of profit such as profit-after-tax (PAT), earnings before interest and tax (EBIT), earnings before interest, tax, depreciation and amortization (EBITDA) of a company using its statement of profit and loss. The students also should be able to make the balance sheet and statement of profit and loss using double entry principle and accrual principle of accounting.		
Module 3	**Accounting Records**	**(2 hours)**
This module enables students in understanding preparation of major accounting records like journal book, ledger books and trail balance with/without adjustments. At the end of this module, students should get conversant with the accounting cycle and records.		
Module 4	**Cash Flows Statement**	**(3 hours)**
This module makes students to understand structure, importance, classification of cash flows and construction of cash flows statement. At the end of this module, students should be able to understand cash flows from operating, investing, and financing activities.		
Module 5	**Measurement and analysis of Depreciation, Cost of Goods Sold (COGS) and Inventory**	**(3 hours)**
This module enables students to understand different methods of depreciation and inventory valuation. Students should also understand implications of these methods of measurement on statement of profit and loss and balance sheet.		
Module 6	**Techniques of Financial Statements Analysis**	**(8 hours)**
This module makes students to understand application of common-size analysis, comparative analysis, and ratio analysis in analysis of balance sheet, statement of profit and loss and statement of cash flows. The financial statements analysis should be from credit analysis, investment analysis		

and forensic perspective. While analysing financial statements, students should be made to understand implications of major accounting policies related to measurement of assets, revenues and expenses in financial statements analysis.

Lab Exercises (If applicable): Not applicable

Textbooks:	
1.	Anthony, Robert Newton, David F. Hawkins, and Kenneth A. Merchant. *Accounting, text and cases*. McGraw-Hill/Irwin, 1999.
2.	Subramanyam K R. *Financial Statement Analysis,* McGraw Hill, 2021.
Reference Books:	
1.	Maher, Michael W., Clyde P. Stickney, and Roman L. Weil. *Managerial accounting: An introduction to concepts, methods and uses*. Rob Dewey, 2006.
2.	White, Gerald I., Ashwinpaul C. Sondhi, and Dov Fried. *The analysis and use of financial statements*. John Wiley & Sons, 2002.
3.	Penman, Stephen H., and Stephen H. Penman. *Financial statement analysis and security valuation*. New York: McGraw-Hill/Irwin, 2010.
4.	Graham, Benjamin and David Le Fevre Dodd (6th Edition). *Security analysis,* McGraw-Hill, 1934.

Proposal for New Course		
Course Number	**:**	MB516
Course Name	**:**	Managerial Economics
Credits	**:**	2-0-0-2 (L-T-P-C)[1]
Prerequisites	**:**	None
Intended for	**:**	MBA
Distribution	**:**	Compulsory
Semester	**:**	Even

Preamble
The primary objective of the course is to make students understand the economic way of thinking about business decisions. It would enable them to develop critical thinking kills and logical way of analyzing business decisions.

Objective
To demonstrate the link between the economic concepts & principles and effective decision making in business and management To apply economic tools in business environment for arriving at suitable firm level decisions for desired business outcomes To apply statistical tools to make evidence-based decisions On completion of this course, the student should be able to: - Understand the role of economic theory in managerial decision making - demonstrate familiarity with various data sources - Apply economic concepts and principles in the real world while taking managerial decisions - Make Efficient firm level business strategies - Analyze data to arrive at business decisions

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

Course Modules with Quantitative lecture hours		
Module 1	**Demand and Supply**	**(8 hours)**
This module introduces Managerial Economics and the problem of scarcity. Thereafter the module discusses the demand and supply side, elasticity, consumer behaviour, marginal analysis.		
Module 2	**Demand Estimation and Forecasting**	**(4 hours)**
The module discusses Basic Estimation Techniques, Estimating Demand Curve, Econometric Models, Forecasting Demand and Interpretation.		
Module 3	**Production and Cost**	**(3 hours)**
Production and Cost in Short and Long Run		
Module 4	**Application of Production and Cost**	**(3 hours)**
Break even Analysis, Production Function and Cost Estimation		
Module 5	**Markets**	**(6 hours)**
Decision Making under Competitive Market, Market Analysis with Market Power		
Perfect Competition, Monopoly and Monopolistic Competitive Market: Market Structure, Profit Maximization, Output and Pricing Decisions		
Module 6	**Strategic Decision Making In Oligopoly Market**	**(4 hours)**
Oligopoly Market Using Game Theory: Simultaneous Decisions, Prisoners' Dilemma, Sequential Games, First Mover and Second Mover Advantage		

Lab Exercises (If applicable):

Application Modules 2, 4 and 6 can be conducted as lab session of 2 hrs each.

Textbooks:	
1.	Dominick Salvatore and Siddhartha K. Rastogi, Managerial Economics, Principles & Worldwide Applications, 9th edition, Oxford University Press 2020
2.	Thomas and Maurice, 2010, Managerial Economics, McGraw Hill
Reference Book:	
1.	Robert S Pindyck, Daniel L Rubinfield and Prem L Mehta, Microeconomics 7th Edition, Pearson 2009.
2.	Paul G. Keat, Philip K Y Young, Stephen E Erfle and Sreejata Banarjee, Managerial Economics: Economic Tools for Today's Decision Makers, 7th Edition, Pearson, 2018

Proposal for New Course		
Course Number	**:**	MB517
Course Name	**:**	Marketing Management
Credits	**:**	2-2 (L-T-P-C)[1]
Prerequisites	**:**	None
Intended for	**:**	MBA
Distribution	**:**	Compulsory
Semester	**:**	I

Preamble
Marketing is not just a specialized business function but an activity that the entire organization has to perform. Marketing operates at three levels in an organization; at a tactical level performing everyday tasks related to customer management, at the strategic level setting direction for organizational growth and profitability making product-market decisions in collaboration with various other functional areas and at the cultural level facilitating organization-wide understanding of customer value and setting up processes for understanding, creating and communicating value to customers, firm and other stakeholders

Objective
The course objectives are: - Understand marketing as a concept, process, and function of the business. - Develop decision-making abilities for designing and executing marketing strategy and marketing program

Course Modules with Quantitative lecture hours		
Module 1	**Introduction to Marketing**	**4**

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

Meaning, Definition, Pillars of Marketing, Marketing Process, Marketing Environment		
Module 2	**Marketing Planning**	**4**
Identification of Market, Segmentation – Meaning and purpose, Types of Segments, Targeting, Positioning, and Marketing Mix.		
Module 3	**Product and Price**	**6**
Product policy, Product classification, New Product Development, Diffusion of Innovation, Product Life Cycle, Brand, Branding, and Brand Equity. Pricing Policy, Types of pricing, Pricing Process		
Module 4	**Promotion and Place**	**6**
Types of Promotion, Advertising, Sales Promotion, Publicity, WOM, IMC Channel Design, Channel conflicts, Wholesale, Retailing		
Module 5	**Contemporary topics**	**4**
Services Marketing, International Marketing, Rural Marketing, Digital Marketing and Green Marketing		

Textbooks:	
1.	Marketing Management (latest edition) – Philip Kotler and Kevin Lane Keller
2.	Marketing Management (latest edition) – Ramaswamy and Namakumari
Reference Book:	
1.	Marketing Management A An Applied Approach
2.	

Proposal for New Course		
Course Number	**:**	MB518
Course Name	**:**	Decision analysis
Credits	**:**	2-0-0-2 (L-T-P-C)[1]
Prerequisites	**:**	None
Intended for	**:**	MBA
Distribution	**:**	Compulsory
Semester	**:**	Even

Preamble
The Primary job of a manger is to arrive at a decision in any given situation. The complex nature of the situation would decide the tools and techniques used in finding a solution. Often decision making requires combining data rationality and intuition. This course focusses on structured approach to decision making.

Objective
To help students to structure a decision-making contest Enable them to generate alternate choices Identify a criterion to make a choice ' Measure the consequence associated with various alternates Identify an optimal/appropriate choice for execution Understand the sensitivity of the choice made to the context(Sensitivity Analysis)

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

Course Modules with Quantitative lecture hours		
Module 1		**(3 hours)**
This module would set the context for decision analysis course. It would discuss a few illustrative examples in details (Eg Bidding problem, Pricing decision, Investment decision, outsourcing decision, Decision under uncertainty)		
Module 2	**Mathematical/Formal representation of consequences**	**(4 hours)**
This module introduces a formal need and ways to measure the consequence of a decision alternate. In specific context explore the use of Linear functions, Piecewise Linear function, Loss functions, Quadratic functions and their relevance, roots of a Quadratic equation, Breakeven Price, exponential and logarithmic functions, Sequences (Geometric and Arithmetic) and functions of many variables		
Module 3	**Review of Probability (Rapid)**	**(6 hours)**
Introduction to Probability and Random variables, Conditional probability, expected value, Summary measures, Fractiles, Measures of dispersion, Chebyshev's inequality, functions of random variables, Joint distribution of random variables, Covariance, Conditional expectations, Binominal, Poisson, and normal Distributions.		
Module 4	**Decision theory**	**(12 hours)**
Method of sensitivity analysis**,** Method of breakeven analysis**,** Decision Problems under uncertainty, Decision trees, expected monetary value as a criterion, expected value of perfect information (EVPI), Structuring and solving sequential decision problem, case studies (2), sampling information, value of sample, optimal sample size to update prior probabilities. expected net gain in sampling, Case studies (2). Cash Equivalent, risk preference		
Module 5	**Loss functions and special structures**	**(3 hours)**
News boy problem and its variations		

Lab Exercises (If applicable): **Not applicable**

Lab to be conducted on a 2-hour slot. It will be conducted in tandem with the theory course so the topics for problems given in the lab are already initiated in the theory class. The topics taught in the theory course should appropriately be sequenced for synchronization with the laboratory.

Textbooks:	
1.	VL Mote and T Madhavan (2016) Operations research, Wiley Indian
2.	PG Moore and HM Thomas (1971) Anatomy of decisions, Penguin Business

Proposal for New Course		
Course Number	**:**	MB519
Course Name	**:**	Creative Thinking, Problem Solving and Decision Making
Credits	**:**	2-0-0-2 (L-T-P-C)[1]
Prerequisites	**:**	None
Intended for	**:**	MBA
Distribution	**:**	Compulsory
Semester	**:**	Odd

Preamble

Normally, thinking skills are based on some structure such as critical thinking, constructive thinking, lateral thinking, creative thinking, vertical thinking, parallel thinking etc. However, all these approaches concentrate more on "talking about problems" rather than "solving problems." Thus, it becomes necessary for the students to connect thinking and problem-solving skills to tackle the complex, nonlinear and uncertain problems in the real-world. This course provides what, why and how of the thinking skill through various toolsets, proper mindsets and appropriate skillsets. This course includes discussions and brainstorming through a range of decision making tools & techniques, brain teasers, games and puzzles. Further, it consists of discussions on heuristics for tackling these types of problems, along with visualization of the contrasting nature of problem solving in humans and computers.

Objective

On completion of this course, the student should be able to:

- acquire creative thinking and problem solving skills to solve managerial problems
- to learn general problem solving strategies and heuristics
- to distil domain independent transferable methodologies and heuristics for tackling various real world problems faced by today's managers

[1] L= Lectures per week, T=Tutorials per week – P = Practical/Lab session per week – C = Credits for course

Course Modules with Quantitative lecture hours		
Module 1	**Introduction**	**(2)**
Understanding problem solving and decision making, Types of problems and decision making		
Module 2	**Human Heritage for Problem Solving and Decision Making**	**(5)**
Creativity and inspiration, Intuition, knowledge, intelligence, wisdom and creativity, empathy, Creativity and evolution. Thinking and its Types, Lean thinking, critical thinking, lateral thinking and design thinking methods, Divergent and convergent thinking.		
Module 3	**Reasoning with Data**	**(5)**
Types of reasoning, deductive vs. inductive reasoning, reasoning with data, role of assumptions and biases, evaluating assumptions, biases in inductive reasoning for handling data, avoiding deductive and inductive reasoning fallacies, abductive reasoning, abduction in the field of artificial intelligence, reasoning backwards; Logical, probabilistic and geometric reasoning, problem solving and thinking traps, and their avoidance.		
Module 4	**Analytical thinking and decision making**	**(3)**
Analytical Thinking and decision making, stages of analytical thinking, data analytic thinking, Analytic hierarchy and network process		
Module 5	**Problem framing and solution**	**(4)**
Identifying and defining problems, building a model, solving the problem through pattern finding, simplifying and eliminating, developing alternatives and evaluating options, what-if analysis, Complex problem solving, six thinking hats.		
Module 6	**Tools, Techniques and Skills**	**(5)**
Interpretation and Ideation techniques: Empathy mapping, mind mapping, journey maps, affinity and cause-effect diagram, pattern recognition; Brainstorming, brain dump, value proposition canvas, SCAMPER. Analysis Methods: Paired Comparison Analysis, Six Thinking Hats, Cost/Benefit Analysis, Decision Trees, Pareto Analysis, Grid Analysis, PMI, Force Field Analysis, Root-Cause Analysis, storyboarding.		
Module 7	Simulation and Optimization for Problem solving and decision making	**(4)**

Simulation and its types, importance of simulation and optimization for problem solving and decision making, role of data and model in simulations. physical simulation vs. computer simulation.

Lab Exercises (If applicable):
Lab to be conducted on a 2-hour slot. It will be conducted in tandem with the theory course so the topics for problems given in the lab are already initiated in the theory class. The topics taught in the theory course should appropriately be sequenced for synchronization with the laboratory.

Reference Book:	
1	T.H. Davenport and J. Kim (2013), Keeping up with the Quants, Harvard Business Review Press, Boston, MA (rs. 1,555)
2	Daniel Kahneman (2012), Thinking, Fast and Slow, Penguin Random House.
3	Robert J. Sternberg Ed. (1994), Thinking and Problem Solving, 2ed., Academic Press.
4	de Bono, E. (1999). *Six Thinking Hats*, New York: MICA Management Resources.
5	Eugene O'Loughlin (2009), An Introduction to Business System Analysis, The Liffey Press, Ireland
6	Gerald F. Smith (1998), Quality Problem Solving, ASQ Quality Press, Wisconsin
7	G. Polya (1988), How to Solve It, Princeton University Press
8	Edward B. Burger and Michael Starbird (2021), 5 Elements of Effective Thinking, Princeton University Press, Oxfordshire
9	Jeanne Liedtka, Andrew King and Kevin Bennett (2013), Solving Problems with Design Thinking, Columbia University Press.
10	Luc De Brabandere and Alan Iny (2013), Thinking in New Boxes, Random House, New York.
11	James L. Adams (2019), Conceptual Blockbusting-Basic Books
12	Tom Kelley and D. Kelley (2013), Creative Confidence, William Collins, London
13	J. Butterfield (2010), Problem Solving and Decision Making, Cengage Learning.
14	Saaty, T.L. (2008), *Creative Thinking Problem Solving and Decision Making*, RWS Publications

15	Paulos, J.A. *Innumeracy: Mathematical Illiteracy and Its Consequences*, New York: Hill and Wang.
16	Fisher, A. (2001). *Critical Thinking: An Introduction*, Cambridge, UK: Cambridge University Press

IIT Mandi
Proposal for a New Course

Course number : **ME-511**
Course Name : **Manufacturing of Composites**
Credit Distribution : *3-0-0-3*
Intended for : **B.Tech. (4th year onwards)/M.Tech./M.Tech.(R)/Ph.D.**
Prerequisite : **Basic Manufacturing Course**
Mutual Exclusion : (*courses with high similarity not allowed to credit by the students after or along with this course, if not relevant courses write* 'None')

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1. Preamble:

Improving manufacturing technology is the greatest challenge today in the field of composites. When composites are chosen for an application principally because of their properties, it is natural that the manufacturing methods would be chosen to optimize those properties. This course will deal manufacturing of composites spanning polymer matrix, metal matrix and ceramic matrix composites. Topics of process modelling in composite manufacturing will also be covered.

2. Course Modules with quantitative lecture hours:

Topic 1: Introduction to Composites: Function of the Matrix and Reinforcement in Composites Matrices: Thermosets and Thermoplastic; Fiber Reinforcement **(3 Hours)**

Topic 2: Properties and testing composites: Properties of Composites; Composites testing; Composites design: Laminate theory, Rule of mixtures, symmetry and balance **(6 Hours)**

Topic 3: Thermoset composite manufacturing processes: Lay-up processes, spray up process; Thermoset Composite manufacturing: Fiber placement process; Thermoset Composite manufacturing: Resin transfer moulding, Vacuum assisted resin infusion microwave curing, recycling of thermoset composites, latest topics in thermoset composite manufacturing. **(6 Hours)**

Topic 4: Thermoplastic composite manufacturing processes: Thermoset Composite manufacturing: Vacuum assisted resin transfer moulding; Thermoset Composite manufacturing: Compression molding process; Thermoset composites manufacturing: Filament winding, Microwave assisted Compression moulding, Additive manufacturing

techniques for thermoplastic composites, latest topics in thermoplastic composite manufacturing. **(6 Hours)**

Topic 5: Metal and Ceramic Matrix Composites: Metal Matrix Composites: Metal matrix and reinforcement; Manufacturing processes for Metal Matrix Composites: Dispersion hardened and particle composite; Manufacturing processes for Metal matrix composites: Layer composites and infiltration method; Ceramic Matrix Composite manufacturing, latest topics in metal and ceramic matrix composite manufacturing. **(7 Hours)**

Topic 6: Secondary Manufacturing Techniques for Composites: Joining techniques: Hot plate welding; Ultrasonic joining; Adhesive binding, composite repair techniques. Machining techniques for composites Machining Techniques for composite, Laser beam machining, electric discharge machining, ultrasonic machining, water jet machining, conventional drilling, milling and turning operations. **(7 Hours)**

Topic 7: Process modelling in Composite Manufacturing: Transport equations for composite processing, constitutive laws and their characterization, Resin viscosity, Reaction kinetics, crystallization kinetics, model simplification and solution, application of numerical model in short fiber composites, thermoplastic composites, thermoset composites. **(7 Hours)**

3. Text books:

(Relevant and Latest, Only 2)

1. **Strong AB. Fundamentals of composites manufacturing: materials, methods and applications. Society of manufacturing engineers; USA, 2008.**
2. **Mallick PK. Fiber-reinforced composites: materials, manufacturing, and design. CRC press; 2007.**

4. References:

(No limit on numbers, relevant standard format can be followed, the formats should be similar)

1. **ASM International Handbook Committee. Composites: Volume 21 of ASM Handbook.**

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)
None

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%:

Not applicable
Approvals:

Other Faculty interested in teaching this course: Dr. Prateek Saxena

Proposed by: Dr. Sunny Zafar **School: SMME**

Signature: **Date:**

Recommended/Not Recommended, with Comments:
_____ **Date:_____**
Chairperson, CPC

Approved / Not Approved
_____ **Date:_____**
Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : **ME-523**
Course Name : Product Design
Credit Distribution : *3-0-0-3, Elective*
Intended for : B.Tech./M.Tech/Ph.D.
Prerequisite : None
Mutual Exclusion : None

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1. Preamble:

The objective of this work is to introduce the perspectives of marketing, design and manufacturing. The content of the course makes the students aware of the realities of the industrial practices and the roles executed by essential members of the product development team. Each chapter begins with the different products ranging from industrial equipment to consumer products.

2. Course Modules with quantitative lecture hours:

Introduction, generic development process, opportunity identification
Characteristics of Successful Product Development, Generic Product Development Process, Concept development, Generic product development process, Opportunity structure and the associate process. [10]

Product planning, customer needs and product specification
Product planning process (Identification, Evaluation, Allocation), Importance of latent needs, Customer needs identification, Target specifications, Final product specifications [09]

Concept generation, selection and testing
Activity of concept generation, Five step method, Choosing a concept, Concept screening and scoring, Concept tests, Survey population and format, response measurement and reflecting on the results [09]

Product architecture, Industrial design, Design for environment and economics
Product Architecture, Modularity, Implications of the Architecture, Establishing the Architecture, Assessing the Need for Industrial Design, Impact of Industrial Design, Quality assessment, Design for environment and associated process, Elements of Economic Analysis, Economic analysis process, Patents and IPR, Case studies across all the disciplines [14]

3. Text books:

1. K T Ulrich and S D Eppinger, Product Design and Development, McGraw Hill, 2000.
2. K Otto and K Wood, Product Design, Pearson Education, Inc. 2001
3. K G Cooper, Rapid Prototyping Technology, Marcel Dekker, Inc. 2001
4. D T Pham and S SDimov, Rapid Manufacturing, Springer-Verlag, 2001

4. Similarity with the existing courses: None

5. Justification of new course proposal if cumulative similarity content is >30%:

Not Applicable

Approvals:

Other Faculty interested in teaching this course: – Dr. Satvasheel Powar

Proposed by: Dr. Mrityunjay Doddamani **School: Mechanical and Materials Engg.**

Signature:  **Date: 12.09.2022**

Recommended/Not Recommended, with Comments:

_____ Date:_____

Chairperson, CPC

Approved / Not Approved

_____ Date:_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : **ME-524**
Course Name : Additive Manufacturing
Credit Distribution : *3-0-0-3, Elective*
Intended for : B.Tech./M.Tech/Ph.D
Prerequisite : None
Mutual Exclusion : None

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1. Preamble:

The objective of this work is to introduce different Additive Manufacturing (AM) processes for various material systems (polymer, metal, ceramics etc). Further, in addition to discussing unusual and emerging applications of AM, the course focusses on medical and aerospace sectors as well. The course also deals with guidelines for AM process selection, design for AM, associated software systems, issues therein and recent developments.

2. Course Modules with quantitative lecture hours:

Introduction to Additive Manufacturing, Data formats and Preprocessing
History, Comparison, Evolution, Methodology, Process chain, Classification, AM file formats, Part orientation, Support structure generation, slicing, Contour and tool path generation and build file preparation [05]

Additive Manufacturing Methods
AM equipment and Materials including Bio-active materials, Vat photo polymerization, Material jetting, Binder jetting, Material extrusion, Sheet lamination, Powder Bed fusion, Direct energy deposition, Thermal spray direct writing, Liquid phase dire deposition, PCB printing, Bioprinting, Concrete 3D printing, 4D printing and Hands on experience on the available AM machines [22]

Design for AM
DFMA, Part replacement, Adapt for AM, Design guidelines (part, support structure, Hole size, layer and wall thickness, residual stresses, optimization), Case studies [05]

AM equipment and materials
Laser, Electron beam, Arc, Beam, In situ monitoring, Polymer, Metal, Ceramics, Recent advances, Powder production and characterization [05]

Post processing, Safety considerations, applications and Industry 4.0
Quality evaluation, Surface finish and geometry improvement, Potential hazards, Powder and chemical hazards, Applications – Aerospace, Defence, Automobile, Biomedical, Rapid tooling, Reverse engineering, Industry 4.0 and future scope of AM [05]

3. Text books:

1. Andreas Gebhardt, Jan-Steffen Hötter, Additive Manufacturing: 3D Printing for Prototyping and Manufacturing, Hanser Publications, 2016.
2. Chua Chee Kai, Leong Kah Fai, 3D Printing and Additive Manufacturing: Principles and Applications, World Scientific, 2014.
3. Hod Lipson, Melba Kurman, Fabricated: The New World of 3-D Printing, Wiley 2013.

4. Patri K. Venuvinod, Weiyin Ma, Rapid Prototyping - Laser-based and Other Technologies, Kluwer Academic Publishers, 2003.

4. Similarity with the existing courses: Partially YES
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	Manufacturing Engineering	ME 308	Fused deposition modeling, Laminated object manufacturing and Stereo-lithography	4%

5. Justification of new course proposal if cumulative similarity content is >30%:

Not Applicable

Approvals:

Other Faculty interested in teaching this course: – Dr. Satvasheel Powar

Proposed by: Dr. Mrityunjay Doddamani **School: Mechanical and Materials Engg.**

Signature: **Date: 30.09.2022**

Recommended/Not Recommended, with Comments:

_____ Date:_____

Chairperson, CPC

Approved / Not Approved

_____ Date:_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number : **PH608**
Course Name : **Computer assisted quantum mechanics**
Credit Distribution : *2-0-3-3*
Intended for : UG/PG/I-PhD/PhD elective
Prerequisite : PH301/PH513 (Quantum Mechanics), PH524/EP403 (Physics of Atoms and Molecules), PH613 (Computational methods for physicists)/EP302 (Computational methods for engineering)
Mutual Exclusion : NA

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1. Preamble:

The objective of this course is to provide an introduction to some of the basic computational techniques used in quantum mechanics. It mainly teaches how to numerically solve Schrodinger equations (both time-independent and time-dependent). It starts with single particle systems and later deals with the many-electron systems. Students have to implement all the methods during the lab sessions using Fortran/C/Python for the specific quantum mechanical problems given. These exercises provide deep insights to some the computational aspects used in quantum mechanics particularly in the field of atomic/molecular/condensed matter physics.

.

The hours mentioned below include lecture and lab sessions

2. Course Modules with quantitative lecture hours:

Module1: The single-particle problem- Time independent Schrodinger equation and its solution with Numerov's method, Bound state solutions for one-dimensional (1D) case such as Harmonic oscillator, Schrodinger equation for central potentials, solutions of hydrogen atom, scattering from different type of central potentials, Response of atoms to external fields

(20 hours)

Module 2: Variational method-The variational principle, Numerical solutions to quantum mechanical problems using variational methods, Plane-wave basis set and Non-orthonormal basis set

(15 hours)

Module 3: Multi-electron systems-Basics of Hartree-Fock (HF) methods and its numerical implementation to a few selected problems, going beyond HF methods, density functional theory and its implementation with some specific examples for simple atomic systems.

(15 hours)

Module 4: Time propagation- Spectral methods, direct numerical integration, split operator and Crank-Nicolson methods. Implementation of these methods to a few quantum mechanical systems

(20 hours)

3. Text books:

1) Computational Physics by J. M. Thijssen (Cambridge University Press, 2007)
2) Computational Quantum Mechanics by J. Izaac and J. Wang (Springer, 2018)

4. References:

1) **Numerical methods in quantum mechanics by** Paolo Giannozzi (Online lecture notes, http://www.fisica.uniud.it/~giannozz/Corsi/MQ/LectureNotes/mq.pdf)
2) **Computational physics,** R. H. Landau, M. J. Páez and C. C. Bordeianu (2015 WILEY-VCH Verlag)

5. Similarity with the existing courses: NA
(Similarity content is declared as per the number of lecture hours on similar topics)

6. Justification of new course proposal if cumulative similarity content is >30%:

NA

Approvals:

Other Faculty interested in teaching this course:

Proposed by: Dr. Hari Varma & Dr. Arko Roy **School:** School of Basic Sciences

Signature: **Date:**

Recommended/Not Recommended, with Comments:

_____ **Date:**_____

Chairperson, CPC

Approved / Not Approved

_____ **Date:**_____

Chairperson, BoA

IIT Mandi
Proposal for a New Course

Course number	**: PH 609**
Course Name	**: Theory of quantum collision and spectroscopy**
Credit Distribution	**:** 3-0-0-3
Intended for	: UG/PG/I-PhD/PhD elective
Prerequisite	:PH301/PH513 (Quantum Mechanics), PH524/EP403(Physics of Atoms and Molecules), PH613: Special topics in Quantum Mechanics
Mutual Exclusion	: None

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1. Preamble:

The objective of this course is primarily to provide a detailed understanding in the field of collision theory and also to provide an introduction to some advanced topics in many-body theory. It introduces the basic formalism in scattering theory and its applications to a number of cases that are of current research interests. Further it introduces some of the many-body theoretical techniques that play very crucial role in order to understand the electronic and photonic collisions processes.

.

2. Course Modules with quantitative lecture hours:

Module 1: Scattering theory-Quantum collisions: Review of Method of Partial wave analysis, and Integral equation of potential scattering; Lippman-Schwinger equation, Born series and approximations, Applications of scattering: Coulomb scattering, Scattering by complex potential Scattering of identical particles, Pseudo-potential and Bethe-Peierls collision theory, Levinson's and Seaton's theorems.

(12 hours)

Module 2: Resonant Scattering-Scattering of partial wave, Resonances in quantum collisions, Breit-Wigner formalism, Fano parameterization of Breit-Wigner formula, correlations induced resonances and shape resonances Broad Vs narrow resonances, Resonance life time, Eisenbud-Wigner-Smith formalism of time-delay in scattering, recent experiments

(8 hours)

Module 3: Many-body formalism

Many-body theory, electron correlations, Second quantization, Many-particle Hamiltonian in occupation number representation, Density fluctuations of electron gas in the Hartree-Fock method, introduction to density functional theory, Bohm-Pines approach to random phase approximation,

(12 hours)

Module4: Relativistic formulation-Foldy-Woutheysen transformations and separation of radial and angular parts of the Dirac equation**,** introduction to relativistic many body theory

(4 hours)

Module 5: Feynman diagrammatic methods-
Schrodinger, Heisenberg and Dirac pictures, Dyson's chronological operator, Gell-Mann-Low Theorem, Rayleigh-Schrodinger perturbation methods and adiabatic switching, Feynman Diagrams, I Order Feynman Diagrams, II and higher order Feynman Diagrams, Linear response of electron correlations

(4 hours)

3. Text books:

1) Physics of Atoms and Molecules, B. H. Bransden & C. J. Joachain (Pearson, 2003)
2) Quantum Theory of Many Particle Systems by A.L.Fetter and J.D.Walecka (Dover, 2003)

4. References:

1) Theory of electron-atom collisions, P. G. Burke and C. J. Joachain (Plenum Press, 1995)
2) Many Electron Theory by Stanley Raimes (Elsevier, 1972)

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	PH613	4 hrs	10%
2.	PH606	4 hrs	10%

6. Justification of new course proposal if cumulative similarity content is >30%: NA

Approvals:

Other Faculty interested in teaching this course:

Proposed by: Dr. Hari Varma & Dr. Arko Roy **School:** School of Physical Sciences

Signature: **Date:**

Annexure B

BTech Course Structure

New structure for BTech (Mechanical Engineering)

Semesters 1 & 2

Sl. No.	Sem	Type	Course Code	Course Name	Credits	Semester credits
1	I	IC	ICXXX	Calculus	2	21
2	I	IC	ICXXX	Complex variables and vector calculus	2	
3	I	IC	IC140	Engineering Graphics for Design	4	
4	I	IC	IC152	Introduction to Python and Data Science	4	
5	I	IC	ICXXX	IC Core basket – 1	3	
6	I	HSS	HSS-1	HSS Course	3	
7	I	IKS	YYXXX	Ikshma Course	3	
1	II	IC	ICXXX	Linear algebra	2	22
2	II	IC	ICXXX	ODE and integral transforms	2	
3	II	IC	IC161	Applied Electronics	3	
4	II	IC	IC 161P	Applied Electronics Lab	2	
5	II	IC	IC252	Probability and Statistics	4	
6	II	IC	IC240	IC Core Basket/ Rigid Body Mechanics	3	
7	II	IC	ICXXX	Foundations of Design Practicum	4	
8	II	IC	IC221P	Physics Practicum	2	

- One HSS in sem 1
- IC basket 2 - Rigid body mechanics in sem 2 as a compulsory course
- The template for first semester may be modified depending on AD Courses' decision for all batches

Semesters 3 & 4

Sl. No.	Sem	Type	Course Code	Course Name	Credits	Semester credits
1	III	IC	IC272	Machine Learning	3	22
2	III	DC	EEXXX	Electrical systems around us	3	
3	III	DC	ME210	Fluid Mechanics	3	
4	III	DC	ME2xx	Product Realization Technology	3	
5	III	DC	ME2xx	Engineering Thermodynamics	4	
6	III	DC	ME206	Mechanics of Solids	3	
7	III	DC	IC241	Materials Science for Engineers	3	
1	IV	IC	IC201P	Design Practicum	3	20
2	IV	DC	MEXXX	Reverse engineering	1	
3	IV	DC	ME205	Machine drawing	3	
4	IV	DC	ME308	Manufacturing Engineering 1	3	
5	IV	DC	ME303	Heat Transfer	3	
6	IV	DC	ME210P	Fluid Mechanics Lab	1	
7	IV	DE	DE-1	Discipline Elective	3	
8	IV	HSS	HSS-2	HSS Course	3	

- Electrical systems around us is a DC for Mech
- Material science in Sem 3 to sync with the new Materials BTech program structure
- One HSS per year is suggested in the template

Semesters 5 & 6

Sl. No.	Sem	Type	Course Code	Course Name	Credits	Semester credits
1	V	DC	ME305	Design of Machine Elements	4	22
2	V	DC	ME307	Energy conversion devices	3	
3	V	DC	ME309	Theory of machines	4	
4	V	DC	ME310	System Dynamics and Control	3	
5	V	DC	MEXXX	Manufacturing Engineering 2	3	
6	V	DC	ME311P	Design Lab 1	1	
7	V	DC	MExxxP	Heat Transfer Lab	1	
8	V	DE	DE-2	Discipline Elective	3	
1	VI	DC	ME312P	Design lab 2	1	17
2	VI	DE	DE-3	Discipline Elective	3	
3	VI	DE	DE-4	Discipline Elective	3	
4	VI	HSS	HSS-3	HSS	3	
5	VI	FE	FE-1	Free Elective	3	
7	VI	ISTP	ISTP	ISTP	4	

- Core courses almost done by 5th semester
- With the knowledge of core curriculum, students can take advanced DE and FE in Sems 6-8
- Given that students get busy with job interview preparation, Sems 6-8 are less loaded than the first 5 semesters.

Semesters 7 & 8

Sl. No.	Sem	Type	Course Code	Course Name	Credits	Semester credits
1	VI/VII	IC	IC010	Internship	2	18
1	VII	DE	DE-5	Discipline Elective	4	
2	VII	FE	FE-2	Free Elective	3	
3	VII	FE	FE-3	Free Elective	3	
5	VII	MTP	-MTP 1	-MTP 1	3	
6	VII	HSS	HSS-4	HSS	3	
1	VIII	FE	FE-4	Free Elective	3	18
2	VIII	FE	FE-5	Free Elective	3	
3	VIII	FE	FE-6	Free Elective	3	
4	VIII	FE	FE-7	Free Elective	4	
5	VIII	MTP	-MTP 2	-MTP 2	5	

- Given that students get busy with job interview preparation, Sems 6-8 are less loaded than the first 5 semesters.
- There is a room to take 3 extra credits per semester to catch-up with any backlogs.

Notes and potential issues

Notes

- This is a suggestive template, as the students are free to take courses as they like as long as the dependencies are maintained and the total number of credits are completed.
- It is suggested that the order suggested for DC must be maintained as they will be offered in the semesters mentioned. Free and Discipline electives can be taken in any order.
- All ME and EN courses will be Discipline Elective courses. If the FAs feel fit, they can suggest (with reasoning) to add a non-ME and non-EN course into the DE list.

Potential issues

- Will the proposed structure allow scope for various Minors?
- Can the students fit in a 6-month internship with this structure?
- Any other issues?

B.Tech. Engineering Physics Semester wise Course Distribution

Sl. No.	Sem	Type	Course Code	Course Name	L	T	P	C	L - T - P - C	Remarks	Semester wise Credits	Credits Completed
				First Semester								
1	I	IC	ICxxx	Calculus	1.5	0.5	0	2	1.5-0.5-0-2			
2	I	IC	ICxxx	Complex and Vector Calculus	1.5	0.5	0	2	1.5-0.5-0-2			
3	I	IC	IC140	Engineering Graphics for Design	2	0	3	4	2-0-3-4			
4	I	IC	IC152	Introduction to Python and Data Science	3	0	2	4	3-0-2-4			
5	I	IC	IC230	Environmental Science (IC Core basket – 1)	2.5/3	0.5/0	0	3	2.5-0.5-0-3	https://cloud.iitmandi.ac.in/f/f7a485930ece4b0fbaa0/		
6	I	HSS	HSXXX	HSS Course	3	0	0	3	3-0-0-3	Preferably English Course for weak students; Other courses may also run		
7	I	IKS	IKS181	Ikshma Course	3	0	0	3	3-0-0-3			
8			ICXXX	Foundations of Design Practicum	1	0	6	4	1-0-6-4	Only one course (FDP/IKS) needs to be taken by students. They may take the other course in the 2nd semester		
										The total credits may be 18 if HSS course is not taken by the student. Accordingly the subsequent number would changed. The compulsary 12 credits from HSS need to be completed by Sem VI. IKS and FDP may run in both semesters. Half of the batch does one course while the other half of the students do the other course. In the second semester, this will be swapped. Accordingly students may do 18-22 credits	21	21
				Second Semester								
1	II	IC	ICxxx	Linear Algebra	1.5	0.5	0	2	1.5-0.5-0-2			
2	II	IC	ICxxx	ODE & Integral Transforms	2.5	0.5	0	2	2.5-0.5-0-2			
3	II	IC	IC161	Applied Electronics	3	0	0	3	3-0-0-3			
4	II	IC	IC 161P	Applied Electronics Lab	0	0	3	2	0-0-3-2			
5	II	IC	IC252	Probability and Statistics	3	0	2	4	3-0-2-4			
6	II	IC	IC121	Mechanics of Particles and Waves (IC Core Basket II)	2.5/3	0.5/0	0	3	2.5-0.5-0-3			
7	II	IC	ICXXX	Foundations of Design Practicum	1	0	6	4	1-0-6-4			
8	II	IC	IC222P	Physics Practicum	0	0	3	2	0-0-3-2			
9	II	IC	IKS	Iksmha courses						IKSHMA course and FDP may swap their batches from 1st year. Total credits may be 20-21 based on the courses	22	43
				Third Semester								
1	III	IC	IC272	Machine Learning	3	0	0	3	3-0-0-3			
2	III	DC	PH301	Quantum Mechanics and Application	3	0	0	3	3-0-0-3			
3	III	DC	EP301	Engineering Mathematics-2	3	1	0	4	3-1-0-4			
4	III	DC	EP321	Foundations of Electrodynamics	3	0	0	3	3-0-0-3			
5	III	DE		Discipline Elective	3	0	0	3	3-0-0-3			
	III	FE		Free Elective	3	0	0	3	3-0-0-3			
6	III	HSS	HSXXX	HSS Course				3				
										Discipline Core and elective courses may be included as per requirement; please fill the details of the courses here. Machine learning may be offered in 3rd semester, and design practicum may be offered in 4th semester		
				Fourth Semester							22	65

1	IV	IC	IC201P	Design Practicum	0	0	6	3				
2	IV	DC	EP403	Physics of Atoms and Molecules	3	0	0	3	3-0-0-3			
3	IV	DC	PH501	Solid State Physics	3	0	0	3	3-0-0-3			
4	IV	DC	EPXXX	Reverse Engineering	0	0	2	1	0-0-2-1			
5	IV	HSS	HSXXX	HSS Course					3-0-0-3			
6	IV	DC	PH302	Introduction to Statistical Mechanics	3	0	0	3	3-0-0-3			
	IV	DE		Discipline Elective				3	3-0-0-3			
	IV	DE		Discipline Elective				3				
	IV											
				Fifth Semester							22	87
1	V	DC	EE....	Device Electronics	3	0	0	3	3-0-0-3	This course is same as EE 311. It is under revision by SCEE and will be floated with a new course number.		
2	V	DC	EP302	Computational Methods for engineering	3	0	0	3	3-0-0-3			
3	V	DC	EP402P	Engineering Physics Practicum	1	0	5	4	1-0-5-4			
5	V	DE		Discipline Elective				3				
6	V	DE		Discipline Elective				3				
		FE		Free Elective				3				
		HSS	HSXXX	HSS Course				3				
											22	109
				Sixth Semester								
1	VI	DC	EP401P	Engineering of Instrumentation	1	0	5	4	1-0-5-4			
2	VI	DC	PH502	Photonics	3	0	0	3	3-0-0-3			
4	VI	DE		Discipline Elective				3				
5	VI	DE		Discipline Elective				3				
6	VI	DE		Discipline Elective				3				
	VI	FE		Free Elective				3				
	VI	ISTP	ISTP	ISTP/Alternatives				4		All core courses need to be completed by 6th semester. If the discipline core courses are completed by 5th semesters, the students may go for semester internship, without much issues of completing the core courses. ISTP and Internship are added to make 18 in Seventh Semester.	19	128
				Seventh Semester								
1	VI/VII	IC	IC010	Internship				2		Internship needs to be completed before start of 8th semester. The grades for the internship may be added to 8th semester grades.	18	146
1	VII	DE	DE-7	Discipline Elective				3				
2	VII	FE		Free Elective				3				
4	VII	FE		Free Elective				3				
6				MTP-1				3				
				Eighth Semester								
1	VIII	DE		Discipline Elective				3				
2	VIII	FE		Free Elective				3				
3	VIII	FE		Free Elective				3				
5	VIII	MTP 2		MTP-2				5			14	160
										If 3 credits HSS is done in Sem I then only one 3 credits needs to be done in either Se V or Sem VI. Hence the total HSS credits would be 12 and Overall Credits would be 160.		

	List of Discipline ElectivesElectives							
Sl. No	Course Code	Course Name	L	T	P	Cr	L-T-P-C	Remarks
1	PH503	Laser and Applications	3	0	0	3	3-0-0-3	
2	PH504	Organic Optoelectronics	3	0	0	3	3-0-0-3	
3	PH507	X-ray as a probe to study the material pro	3	0	0	3	3-0-0-3	
4	PH508	Magnetism and Magnetic Materials	3	0	0	3	3-0-0-3	
5	PH601	Mesoscopic Physics and Quantum Transp	3	0	0	3	3-0-0-3	
6	PH603	Advanced Condensed Matter Physics	3	0	0	3	3-0-0-3	
7	PH612	Nuclear and Particle Physics	3	0	0	3	3-0-0-3	
8	PH613	Special Topics in Quantum Mechanics	3	0	0	3	3-0-0-3	
9	PH605	Superconductivity	3	0	0	3	3-0-0-3	
10	PH606	Quantum Field Theory	3	0	0	3	3-0-0-3	
11	PH604	Optical Properties of Solids	3	0	0	3	3-0-0-3	
12	PH528	Introduction to General Relativity	3	0	0	3	3-0-0-3	
13	PH607	Physics of Ultra cold Quantum Gases	3	0	0	3	3-0-0-3	
14	PH521	Electromagnetic Theory	4	0	0	4	4-0-0-4	
15	PH608	Computer Assisted quantum mechanics	3	0	0	3	3-0-0-3	
16	PH609	Theory of quantum collision and spectros	3	0	0	3	3-0-0-3	
17	MA513	Ordinary Differential Equations	3	1	0	4	3-1-0-4	
18	MA522	Partial Differential Equations	3	1	0	4	3-1-0-4	
19	MA511	Real Analysis	3	1	0	4	3-1-0-4	
20	MA521	Functional Analysis	3	1	0	4	3-1-0-4	
21	MA512	Linear Algebra	3	1	0	4	3-1-0-4	
22	EE614	Optical communication systems	3	0	0	3	3-0-0-3	
23	EE611	VLSI Technology	3	0	0	3	3-0-0-3	
24	EE520	Microelectronics Devices and Modelling	3	0	0	3	3-0-0-3	
25	EE307	Theory of Measurement	3	0	0	3	3-0-0-3	
26	EE621	Radiating Systems	3	0	0	3	3-0-0-3	
27	EE551	Applied Photonics for Scientists and Engi	2	1	0	3	2-1-0-3	
28	CS241	Introduction to Cryptography	3	0	0	3	3-0-0-3	has not been offered for a long time
29	CS208	Mathematical Foundations of Computer S	3	0	0	3	3-0-0-3	
30	CS202	Data Structures and Algorithms	3	0	0	3	3-0-0-3	
31	CS403	Algorithm Design and Analysis	3	0	0	3	3-0-0-3	
32	ME307	Energy Conversion Devices	3	0	0	3	3-0-0-3	
33	ME615	Applied Computational Fluid Dynamics	3	0	0	3	3-0-0-3	
34	ME210	Fluid Mechanics	3	0	0	3	3-0-0-3	
35	ME509	Nano Manufacturing	3	0	0	3	3-0-0-3	
36	ME603	Advanced Fluid Mechanics	3	0	0	3	3-0-0-3	
37	PH701	Introduction to molecular simulations	2	0	4	4	2-0-4-4	
38	PH706	Introduction to stochastic problems in phy	3	0	0	3	3-0-0-3	
39	PH621	Computational Methods for Physicists	2	0	4	4	2-0-4-4	
40	EP502	Informatics for Material Design	2	0	2	3	2-0-2-3	we have to check if this has been approved by the BoA
41	MA516	Topology	3	1	0	4	3-1-0-4	New additions based on students' suggestions
42	EN502	Emerging energy sources	3	0	0	3	3-0-03	
43	DS201	Data Handling and Visualization	2	0	2	3	2-0-2-3	
44	DS404	Information Security and Privacy	3	0	0	3	3-0-0-3	In place of Introduction to Cryptography
45	CS309	Information and Database Systems	3	0	2	4	3-0-2-4	
46	CS671	Deep Learning and Applications	3	1	0	4	3-1-0-4	
47	CS672	Advanced Topics in Deep Learning	3	0	2	4	3-0-2-4	
48	EE203	Network theory	3	0	0	3	3-0-0-3	
49	EE512	CMOS Analog IC Design	3	0	2	4	3-0-2-4	
50	DS301	Mathematical Foundations of Data Scienc	3	0	1	4	3-1-0-4	
51	DS403	Introduction to Statistical Learning	2	0	2	3	2-0-2-3	
52	CS511	Introduction to Probability	2	0	0	2	2-0-0-2	
53	ME503	Heat Transfer				3		
54	MA560	Nonlinear Dynamics and Chaos	3	0	0	3	3-0-0-3	
55	ME210	Fluid Mechanics	2.5	0.5	0	3	2.5-0.5-0-3	
56	DS401	Optimization for Data Science	3	0	0	3	3-0-0-3	
57	CS304	Formal Language and Automata Theory	3	0	0	3	3-0-0-3	
58	EE211	Analog Circuit Design	2	0	2	3	2-0-2-3	
59	EE511	Computer Vision	3	0	2	4	3-0-2-4	
60	EE519P	CMOS Digital IC Design Practicum	1	0	2	2	1-0-2-2	
61	EE524	Digital MOS LSI Circuits	3	0	0	3	3-0-0-3	
62	EE534	Probability and Random Processes	3	0	0	3	3-0-0-3	
63	EE593	Low power VLSI Design	3	0	0	3	3-0-0-3	
	NOTE:							
	This Discipline Electives list will be maintained by Academics Office. Elective courses are not allowed to delete. The addition of courses is permitted. This list may be modified during the time of next curriculum revision. UG students may preferably be allowed to take upto 5 level courses as Discipline Courses. 6 level courses may be offered as free electives.							

SUMMARY

Semester	DC	DE	DC + DE
III	10	3	16
IV	10	6	13
V	10	6	16
VI	7	9	16
VII	0	3	3
VIII	0	3	3
Total	37	30	67

Symbol	Course Type	Credits	
DC	Discipline core	37	
DE	Discipline elective	30	
FE	Free elective	21	
HSS	Humanities and Social Science Course	12	
IC	Institute Core	45	Including the baskets
IKS	Indian knowledge system	3	
ISTP	Interactive Socio-Technical Practicum	4	
MTP 1	Major Technical project 1	3	
MTP 2	Major Technical project 2	5	
		160	

Double major Courses

Sl. No.	Type	Course Code	Course Name	L	T	P	C	L - T - P - C
1	DC	PH301	Quantum Mechanics and Application	3	0	0	3	3-0-0-3
2	DC	EP301	Engineering Mathematics-2	3	1	0	4	3-1-0-4
3	DC	EP321	Foundations of Electrodynamics	3	0	0	3	3-0-0-3
4	DC	PH302	Introduction to Statistical Mechanics	3	0	0	3	3-0-0-3
5	DC	EP403	Physics of Atoms and Molecules	3	0	0	3	3-0-0-3
6	DC	PH501	Solid State Physics	3	0	0	3	3-0-0-3
7	DC	EP402P	Engineering Physics Practicum	1	0	5	4	1-0-5-4
8	DC	PH502	Photonics	3	0	0	3	3-0-0-3
9	IC	IC121	Mechanics of Particles and Waves	3	0	0	3	3-0-0-3
10	DE		Discipline Elective				3	
11	DE		Discipline Elective				3	
12	DE		Discipline Elective				3	
							38	

M.Sc. (PHYSICS)

Sl. No.	Semester	Type	Course Code	Course Name	L	T	P	C	L - T - P - C	Semester wise Credits	Credits Completed	Remarks
1	I	Core	PH-511	Mathematical Physics	4	0	0	4	4-0-0-4			
2	I	Core	PH-512	Classical Mechanics	4	0	0	4	4-0-0-4			
3	I	Core	PH-513	Quantum Mechanics	3	0	0	3	3-0-0-3			
4	I	Core	PH-514	Electronics	3	0	0	3	3-0-0-3			
5	I	Core	PH-515P	Physics Lab	0	0	5	3	0-0-5-3			
6	I	Core	HS-541	Technical Communications	1	0	0	1	1-0-0-1			
7	I	Elective		Discipline elective/Free elective	3	0	0	3	3-0-0-3			Two Free Elective courses have to be completed. These courses can be taken in any semester.
										21	**21**	
8	II	Core	PH-521	Electromagnetic Theory	4	0	0	4	4-0-0-4			
9	II	Core	PH-522	Statistical Mechanics	4	0	0	4	4-0-0-4			
10	II	Core	PH-523	Condensed Matter Physics	3	0	0	3	3-0-0-3			
11	II	Core	PH-524	Atomic and Molecular Physics	3	0	0	3	3-0-0-3			
12	II	Core	PH-621	Computational Methods of Physics	2	0	4	4	2-0-4-4			
13	II	Elective		Discipline elective/Free elective	3	0	0	3	3-0-0-3			
										21	**42**	
14	III	Core	PH-613	Special Topics in QM	3	0	0	3	3-0-0-3			
15	III	Core	PH-614	Seminar and Report	0	0	4	2	0-0-4-2			
16	III	Core	PH-525P	Electronics Lab Practicum	0	0	6	3	0-0-6-3			
17	III	Core	PH-518P	PG Project - I	0	0	6	3	0-0-6-3			
18	III	Elective		Discipline Elective	3	0	0	3	3-0-0-3			
19	III	Elective		Discipline Elective	3	0	0	3	3-0-0-3			
20	III	Elective		Discipline elective/Free elective	3	0	0	3	3-0-0-3			
										20	**62**	
21	IV	Core	PH-519P	PG Project - II	0	0	16	8	0-0-16-8			
22	IV	Core	PH-611P	Experimental Research Techniques	0	0	8	4	0-0-8-4			
23	IV	Elective		Discipline Elective	3	0	0	3	3-0-0-3			
24	IV	Elective		Discipline elective/Free elective	3	0	0	3	3-0-0-3			
										18	**80**	

I-Ph.D. (Physics)

Sl. No.	Semester	Type	Course Code	Course Name	L	T	P	C	L - T - P - C	Semester wise Credits	Credits Completed	Remarks
1	I	Core	PH-511	Mathematical Physics	4	0	0	4	4-0-0-4			
2	I	Core	PH-512	Classical Mechanics	4	0	0	4	4-0-0-4			
3	I	Core	PH-513	Quantum Mechanics	3	0	0	3	3-0-0-3			
4	I	Core	PH-514	Electronics	3	0	0	3	3-0-0-3			
5	I	Core	PH-515P	Physics Lab	0	0	5	3	0-0-5-3			
6	I	Core	HS-541	Technical Communications	1	0	0	1	1-0-0-1			
7	I	Core	PH-516	Research Project - I	0	0	4	2	0-0-4-2			
8	I	Core	PH-517	Research Project - II (Winter)	0	0	8	4	0-0-8-4			
										24	**24**	
9	II	Core	PH-521	Electromagnetic Theory	4	0	0	4	4-0-0-4			
10	II	Core	PH-522	Statistical Mechanics	4	0	0	4	4-0-0-4			
11	II	Core	PH-523	Condensed Matter Physics	3	0	0	3	3-0-0-3			
12	II	Core	PH-524	Atomic and Molecular Physics	3	0	0	3	3-0-0-3			
13	II	Core	PH-621	Computational Methods of Physics	2	0	4	4	2-0-4-4			
14	II	Elective		Discipline Elective	3	0	0	3	3-0-0-3			
15	II	Core	PH-526	Research Project-III	0	0	6	3	0-0-6-3			
16		Core	PH-527	Research Project-IV (Summer)	0	0	6	3	0-0-6-3			
										27	**51**	
17	III	Core	PH-613	Special Topics in QM	3	0	0	3	3-0-0-3			
18	III	Core	PH-614	Seminar and Report	0	0	4	2	0-0-4-2			
19	III	Core	PH-525P	Electronics Lab Practicum	0	0	6	3	0-0-6-3			
20	III	Core	PH-615P	Mini Thesis - I	0	0	6	3	0-0-6-3			
21	III	Elective		Discipline Elective	3	0	0	3	3-0-0-3			
22	III	Elective		Discipline Elective	3	0	0	3	3-0-0-3			
23	III	Elective		Free Elective	3	0	0	3	3-0-0-3	Can be done in any semester instead of Discipline elective		
										20	**71**	
24	IV	Core	PH-616P	Mini Thesis - II	0	0	16	8	0-0-16-8			
25	IV	Core	PH-611P	Experimental Research Techniques	0	0	8	4	0-0-8-4			
26	IV	Elective		Discipline Elective	3	0	0	3	3-0-0-3			
27	IV	Elective		Discipline Elective	3	0	0	3	3-0-0-3	Optional May finish in V/VI semester		
28	IV	Elective		Any Elective	3	0	0	3	3-0-0-3	Optional May finish in V/VI semester		
										Minimum 15	Minimum 80	
										Students need to finish a minimum of 80 credits by the end of fourth semester		
27	V	Elective			3	0	0	3	3-0-0-3	minimum 0 maximum 9		
28	VI	Elective			3	0	0	3	3-0-0-3	minimum 0 maximum 9	Minimum 89	
										Students must finish all 89 credits by the end of sixth semester		

Discipline Electives

Sl. No.	Course Code	Course Name	L	T	P	C	L - T - P - C
1	PH-502	Optics/Photonics	3	0	0	3	3-0-0-3
2	PH-503	Laser and Applications	3	0	0	3	3-0-0-3
3	PH-507	X-rays as a probe to study material properties	3	0	0	3	3-0-0-3
4	PH-508	Magnetism and Magnetic Materials	3	0	0	3	3-0-0-3
5	PH-528	Introduction to General Relativity	3	0	0	3	3-0-0-3
6	PH-601	Mesoscopic Physics and Quantum Transport	3	0	0	3	3-0-0-3
7	PH-603	Advanced Condensed Matter Physics	3	0	0	3	3-0-0-3
8	PH-604	Optical Properties of Solids	3	0	0	3	3-0-0-3
9	PH-605	Superconductivity	3	0	0	3	3-0-0-3
10	PH-606	Quantum Field Theory	3	0	0	3	3-0-0-3
11	PH-607	Physics of Ultracold Quantum Gases	3	0	0	3	3-0-0-3
12	PH-608	Computer assisted quantum mechanics	2	0	3	3	2-0-3-3
13	PH-609	Theory of quantum collision and spectroscopy	3	0	0	3	3-0-0-3
14	PH-612	Nuclear and Particle Physics	3	0	0	3	3-0-0-3
15	PH-701	Introduction to Molecular Simulations	2	2	0	4	2-2-0-4
16	PH-706	Introduction to Stochastic Problems in Physics	3	0	0	3	3-0-0-3
17	EN-511	Computational Methods in Material Science	1	0	6	4	1-0-6-4
18	EP-502	Informatics for Materials Design	2	0	2	3	2-0-2-3

Program: B.Tech. in Civil Engineering

Table 1: Overall Credit Distribution

Division	Sub-division	Credits
Institute Core	IC Compulsory	39
	IC Baskets	6
	HSS	12
	IKSHMA	3
Discipline	Discipline Core	49
	Discipline Electives	17
Electives	Free Electives	22
	MTP + ISTP or Equivalent	12
	Total	**160**

Table 2: List of IC Compulsory Courses

Sl. No.	Course Code	Course Name	Credits
1	ICXXX	Calculus	2
2	ICXXX	Complex Variables and Vector Calculus	2
3	ICXXX	Linear Algebra	2
4	ICXXX	ODE & Integral Transforms	2
5	IC010	Internship	2
6	IC102P	Foundations of Design Practicum	4
7	IC140	Engineering Graphics	4
8	IC152	Introduction to Python and Data Science	4
9	IC161	Applied Electronics	3
10	IC161P	Applied Electronics Lab	2
11	IC201P	Design Practicum	3
12	IC222P	Physics Practicum	2
13	IC252	Probability and Statistics	4
14	IC272	Machine Learning	3
		Total	**39**

Table 3: IC Basket Courses

Sl. No.	Basket	Course Code	Course Name	Credits
1	IC-I	IC230	Environmental Science	3
2	IC-II	IC240	Mechanics of Rigid Bodies	3

Table 4: Discipline Core Courses

Sl. No.	Course Code	Course Name	Credits
1	CE201	Surveying Traditional and Digital	2-0-4-4
2	CE251#	Hydraulics Engineering	3-0-0-3
3	CE252	Geology and Geomorphology	2-0-2-3
4	CE202*	Introduction to Civil Engineering Profession	1-0-0-1
5	CE203*	Construction Materials	3-0-0-3
6	CE203P*	Building Materials Lab	0-0-2-1
7	CE301#	Strength of Materials and Structures	3-0-0-3
8	CE301P#	Strength of Materials and Structures Lab	0-0-2-1
9	CE302#	Geotechnical Engineering I	3-0-0-3
10	CE302P#	Geotechnical Engineering Lab	0-0-2-1
11	CE303#	Water Resources Engineering	3-0-0-3
12	CE304P	Hydraulics Engineering Lab	0-0-2-1
13	CE305P#&	Environmental Engineering Lab	0-0-2-1
14	CE351	Design of Reinforced Concrete Structures	2-1-0-3
15	CE352	Transportation Engineering	3-0-0-3
16	CE352P*	Transporting Engineering Lab	0-0-2-1
17	CE353P	Civil Engineering Drawing	0-0-2-1
18	CE403#&	Water and Wastewater Engineering	3-0-0-3
19	CE401	Design of Steel Structures	2-1-0-3
20	CE402	Geotechnical Engineering II	3-0-0-3
21	CE404	Analysis of Structures	3-0-0-3
22	CEXXX	Reverse Engineering	0-0-2-1
		Total	**49**

***New course**

#minor modifications of contents in existing course

& course title change

Table 5: Summary of Recommended Credit Distribution Across the Semesters

	Institute Core	Discipline Core and Electives	Free Electives	Other Electives	Total
Semester 1	22	0	0	0	18
Semester 2	21	0	0	0	23
Semester 3	9	12	0	0	21
Semester 4	3	15	3	0	21
Semester 5	3	14	3	0	22
Semester 6	0	14	6	0	20
Semester 7	2	6	6	7	21
Semester 8	0	6	6	5	17
	60	**66~67***	**22~24***	**12**	**160~163***

**1 extra for DE (3×6 instead of 17), 2 extra for FE (3×8 instead of 22) credits are shown in the semesterwise distribution. Students can have the flexibility to choose suitable courses to complete the categorywise credits.*

Semester-wise Course Distribution

Semester – I

Sl. No.	Course Code	Course Name	Credits
1	IC140	Engineering Graphics	4
2	ICXXX	Math 1	2
3	ICXXX	Math 2	2
4	IC152	Introduction to Python and Data Science	4
5	IC230	Environmental Science	3
6	HSXXX/IKXXX	HSS Course/IKSHMA Course	3
7	IC102P	Foundations of Design Practicum	4
		Total Credit	**22**

Semester – II

Sl. No.	Course Code	Course Name	Credits
1	IC222P	Physics Practicum	2
2	ICXXX	Math 3	2
3	ICXXX	Math 4	2
4	IC161	Applied Electronics	3
5	IC161P	Applied Electronics Lab	2
6	IC240	Mechanics of Rigid Bodies	3
7	IC252	Probability and Statistics	4
8	IKXXX/HSXXX	IKSHMA Course/HSS Course	3
		Total Credit	**21**

Semester – III

Sl. No.	Course Code	Course Name	Credits
1	CE202	Introduction to Civil Engineering	1-0-0-1
2	CE252	Geology and Geomorphology	2-0-2-3
3	CE203	Construction Materials	3-0-0-3
4	CE203P	Building Materials Lab	0-0-2-1
5	CE301	Strength of Materials and Structures	2-1-0-3
6	CE301P	Strength of Materials and Structures Lab	0-0-2-1
7	IC201P	Design Practicum	3
8	IC272	Machine Learning	3
9	HSXXX	HSS Course	3
		Total Credit	**21**

Semester – IV

Sl. No.	Course Code	Course Name	Credits
1	CE201	Surveying Traditional and Digital	2-0-3-4
2	CE251	Hydraulics Engineering	3-0-0-3
3	CE302	Geotechnical Engineering I	3-0-0-3
4	CE302P	Geotechnical Engineering Lab	0-0-2-1
5	CE304P	Hydraulics Engineering Lab	0-0-2-1
6	CE404	Analysis of Structures	3-0-0-3
7	FE-1	Free Elective	3
8	HSXXX	HSS Course	3
		Total Credit	**21**

Semester – V

Sl. No.	Course Code	Course Name	Credits
1	CE303	Water Resources Engineering	3-0-0-3
2	CE 351	Design of Reinforced Concrete Structures	2-1-0-3
3	CE352	Transportation Engineering	3-0-0-3
4	CE352P	Transporting Engineering Lab	0-0-2-1
5	CE353P	Civil Engineering Drawing	0-0-2-1
6	CE402	Geotechnical Engineering II	3-0-0-3
7	FE-2	Free Elective	3
8	HSXXX	HSS Course	3
		Total Credit	**20**

Semester – VI

Sl. No.	Course Code	Course Name	Credits
1	CE305P	Environmental Engineering Lab	0-0-2-1
2	CE401	Design of Steel Structures	2-1-0-3
3	CE403	Water and Wastewater Engineering	3-0-0-3
4	CEXXX	Reverse Engineering	1
5	DE-1	Discipline Elective	3
6	DE-2	Discipline Elective	3
7	FE-3	Free Elective	3
8	FE-4	Free Elective	3
		Total Credit	**20**

Internship Credit During Any Suitable Break Period After Semester – V

(To be added with 7th Semester)

Sl. No.	Course Code	Course Name	Credits
1	IC 010	Internship	2

Semester – VII

Sl. No.	Course Code	Course Name	Credits

1	DE-3	Discipline Elective	3
2	DE-4	Discipline Elective	3
3	FE-5	Free Elective	3
4	FE-6	Free Elective	3
5	MTP-1 or Equivalent	Major Technical Project	3
6	DP 301P or Equivalent	ISTP	4
		Total Credit	**19**

Semester – VIII

Sl. No.	Course Code	Course Name	Credits
1	DE-5	Discipline Elective	3
2	DE-6	Discipline Elective	3
3	FE-7	Free Elective	3
4	FE-8	Free Elective	3
5	MTP-2 or Equivalent	Major Technical Project	5
		Total Credit	**17**

ANNEXURE-C

Center for Climate Change and Disaster Resilience Research (C3DAR)

Introduction

Climate change is a major challenge the world is facing today, with impacts already being felt globally. IPCC (2022) highlights that the rapidly accelerating climate change has altered the characteristics of the hydrological cycle resulting in higher intensity and frequency of climate and weather extremes. Climate hazards propagate through the atmosphere, hydrosphere, and lithosphere leading to related disaster events. These include large-scale events such as droughts, floods, hot and cold extremes, and leading to local-scale disasters such as landslides, cloud bursts, forest fires and flash floods. While large-scale events demand global interventions and stakeholders, the risk mitigation strategies, both structural and non-structural, can be taken up for localised adaptation to extreme events. However, for designing better interventions, it is critical to understand not only the localised causative factors behind the climate change, such as the behaviour of air pollutants, aerosol concentration and, carbon transport in the atmosphere, but also the impact of climate change on the ecosystem, people and infrastructure better.

In the Indian subcontinent, especially in the Indian Himalayan Region (IHR), a rapid increase in extreme events coupled with rapid infrastructural development have significantly impacted the water resources, agriculture, and infrastructure of the region. These impacts can potentially affect vulnerable communities, living in poverty or in remote or isolated areas, disproportionately . Additionally, the tectonic movements leading to earthquake hazard may add momentary yet disaster risk compounding to the long-term but steadily increasing climate risk. The approaches and schemes for adaptation and/or mitigation for each of the events are different. The design of these measures demands knowledge of the global to local conditions investigations, data collection and systematic field, laboratory and/or numerical analysis. Finally, these strategies should be implemented in coordination with various stakeholders with acceptance from the pertinent communities.

Situated in the Shivalik range of the mid-Himalayan region in India, the IIT Mandi research community took the advantage of being located in the serene yet disaster-prone mountainous range. The critical combination of wideband expertise available with IIT Mandi, ready-to-adopt society, easily reachable sites and data-intense conditions surely motivate the need for such a centre. The centre is intended to focus on encouraging brainstorming, innovation, testing, and reaching society with implementable and affordable schemes.

The 'Center for Climate Change and Disaster Resilience Research' at IIT Mandi would be a valuable resource for addressing the challenges of climate change in the IHR and beyond. By bringing together experts from various fields, conducting research, developing and implementing adaptation and mitigation strategies, and engaging with stakeholders, the centre would work towards understanding and addressing the impacts of climate change and associated disasters and in order to improve the resilience of communities in the region.

Objectives

1. National level facility creation for field-laboratory-numerical studies in the domain of climate change and disaster re.
2. Encourage innovation, critical thinking, teaching and learning aspects
3. Developing innovative and sustainable solutions for resilient infrastructure with a specific focus on mountainous hazards.
4. Developing informed mitigation measures/schemes through exploiting the technological advancements and AI/ML based tools.
5. Increasing the outreach by short-term courses, aligned diploma and masters programs, training and capacity building programs.
6. Creation of national level competence to address the domain issues for state-region-local requirements

Focus

The realm of the center falls into the core expertise of IIT Mandi faculty working in sub-areas as listed below:

Domain	**Sub-areas**
Climate Change studies	Climate Change Impact Assessment, Data Assimilation Adaptation planning, Weather Forecasting, Extreme Event Forecasting
Atmosphere	Air pollution, Aerosols, Black and brown carbon
Hydrosphere	Glaciers, Avalanches, water, rainfall patterns, flood, drought, soil moisture
Lithosphere	Landslide, Earthquake and liquefaction
Infrastructure	Hazard and risk management, infrastructural disaster management, Service life prediction, Smart infrastructure/cities

Existing and Proposed labs and research groups

- ➔ Extreme Hydroclimatology Lab,
- ➔ i4s lab
- ➔ Geohazard Lab
- ➔ Theoretical and Computational Geomechanics Research Lab
- ➔ Atmospheric Chemistry and Climate Change Lab
- ➔ Computational Engineering Seismology
- ➔ Sustainable Infrastructure Lab
- ➔ Structural Dynamics and Uncertainties (STUDENT) Research Group
- ➔ MH-RESIST - Multi-Hazard RESilient Infrastructure SysTems Research Lab
- ➔ Computational Engineering Seismology
- ➔ Sustainable Infrastructure Lab

Deliverables

High quality research
International collaborations
Capacity building and workshops
Certificate and higher level courses and programs
One stop solution for life-line departments IPH, PWD, NHAI, DDMA, SDMA, NDMA

technical consultancy on detailed project reports, technical consultation, extreme event reports and mitigation schemes.

Sustainable Development Goals (SDGs) aspects targeted (CoP: 27)
SDG 6: Clean water and Sanitation
SDG 9: Innovation, Industry and Infrastructure
SDG 11: Sustainable cities and communities
SDG 13: Climate action
SDG 17: Partnership for the goals

Collaborations (Indian and International)

- National Institute of Disaster Management (NIDM)
- IITs [Bombay, Roorkee, Ropar, Indore, Madras, Guwahati, Kanpur, Gandhinagar, Delhi]
- IISc Banglore
- Central Building Research Institute,
- IISER Kolkata,
- Jawaharlal Nehru University,
- Tezpur University,
- National Center for Polar and Ocean Research
- International
- UCL London
- Milan: Prof. Roberto Paolucci (Polytechnic University of Milan)
- National Institute of Hydrology Roorkee
- University of California Merced
- KAUST-Saudi Arabia
- Team i4s, India, Rennes, France, Dingsheng Li, Shantanu Univ, China
- Jafar Ali parole, Kuwait
- Vincenzo Nava, Spain"
- Durham University, UK
- Physical Research Laboratory
- National Physical Laboratory,
- Linkoping University (Sweden),
- Karolinska Institut (Sweden)
- Jinan University (China),
- Sun Yat-sen University (China)
- CNRS (France)
- National University of Singapore
- Monash University,
- University of Adelaide
- TU Munich
- Kyoto University
- NTNU Norway
- UNISA, Italy
- TAMU, Arlington
- UIC, Chicago

- University of Brussels, Belgium

Industries/Organizations:

- National Disaster Management Authority (NDMA)
- State and District Disaster Management Authority (SDMA-HP, Mandi, Kinnaur, Kangra, Chamba)
- Intiot Services Pvt Ltd.
- Macaferri Env Sol
- Techfab
- Line departments (IPH, PWD, NHAI,

Annexure D

Proposal for the establishment of the Centre for Quantum Technologies (CQT) @ IIT Mandi

1. Introduction

Advent of 'Quantum Science' in the last century has brought enormous growth in our understanding of nature at atomic level, resulting in the rapid and dramatic changes in the development of society. There are hardly very few avenues in the scientific journey of human, which can be worked out without the knowledge of quantum science. The basic notion of quantum mechanics that nature exhibits dual characteristics (particle as well as wave like) at atomic level has challenged the classical way of understanding nature. This new way of understanding has not only helped in the answering some common questions of nature such as color, transparency and opaqueness of a substance, biological compasses, electromagnetic radiations, but also resulted in harnessing the collective behavior of quantum particles at mesoscopic scale, which has led to the technology of everyday use such as toaster, fluorescent light, computer, mobile phone, transistor, Laser, microscopy, Global Positioning System, Magnetic Resonance Imaging, Telecommunication etc.

Over the last half of century, development of solid-state transistor and high storage memory devices led to the unprecedented fast growth of the human civilization. This technology is based on the principles of quantum mechanics and can be termed as 'Quantum 1.0'. Now, a second revolution in the quantum technology is on the card, which promises more precise, advanced, and effective methods for the transfer of information, sensing and computation. This technology, again based on the concepts of fundamental principle of quantum mechanics can be termed as 'Quantum 2.0', which encompasses Quantum Computing, Quantum Communication, Quantum Metrology and Sensing, Quantum Materials, Quantum Entanglement, Ion trap etc. Considering the future prospective and growth forecast, it is quintessential to explore the fundamental and technological aspects of the Quantum 2.0, we propose the establishment of a 'Center of Quantum Technologies (CQT)' at IIT Mandi.

2. Objectives

The primary objectives of CQT are:

(i) Establish a national laboratory with state-of-the-art facilities to test all hallmarks of optical quantum computing, including a Quantum supremacy testing facility.

(ii) Construction of a prototype facility for a quantum computer and cryptographic devices.

(iii) Development of a reliable and scalable optical vortex-based quantum computing platform that can solve specific problems.

(iv) Development and optimization nanowire self-assembly as encoding of quantum algorithms for the optical vortex-based quantum computer.

(v) Establish a roadmap for future developments in harvesting topological photons interacting like electronic devices as an interaction of cognitive choices during room-temperature quantum processing.

(vi) Nurturing the young engineers and scientists for the upcoming quantum technologies through the academic degree programs like Ph.D., M.Tech, M.Sc. and B.Tech.

3. Research Verticals of CQT

- Quantum Optical Computing
- Quantum Communication
- Quantum Cryptography
- Quantum Sensing and Metrology
- Quantum Materials
- Quantum Optics

4. Uniqueness

Some of the unique aspects where the proposed center would focus on are:

- Center with team members from across the globe.
- We aim to build an operational quantum vortex-based computer.
- Focus on the development of the operational quantum computer with features comparable with already commercialized quantum computers.
- Construction of a prototype facility for a quantum computer and cryptographic devices.
- Introducing multi-institutional PhD program in quantum technologies with collaboration with universities/institutes at Japan, USA, Germany, UK, IITs etc.
- Introducing new postgraduate program (M.Tech.) and specializations program for B.Tech. in quantum computing and quantum communication.

5. Team Members

- Anirban Bandyopadhyay (Neuromorphic computing, NIMS Japan, IIT Mandi)

- Chandra Shekhar Yadav (Low Temperature Physics, IIT Mandi)
- Suman Kalyan Pal (Ultrafast optics, light-matter interaction, IIT Mandi)
- Pradyumna Pathak (Mechano-optics, optical cavity, IIT Mandi)
- Hari Varma (Atomic trap for light-matter interaction, IIT Mandi)
- Ajay Soni (Quantum Transport and Nano functional devices, IIT Mandi)
- Girish Sharma (Quantum materials, IIT Mandi)
- Arko Roy (Theoretical cold atom physics, IIT Mandi)
- Aniruddha Chakraborty (Theoretical & Computational Chemical Physics, IIT Mandi)
- Rabindra Pratap Singh (Quantum optics & Quantum communication, PRL, India)
- Ranjit Pati (Quantum theory of atomic structures, MTU, USA)
- Martin Timms (Engineering commercial portable quantum computer, UK)
- Pushpendra Singh (Quantum electronics and optics, NIMS Japan)
- Pathik Sahoo (Organic nanowire synthesis, NIMS Japan)
- Jhimli Sarkar (Microfluid gel chip for cryptography, IIT Kharagpur)
- Arunagshu Debnath (Qauntum Algorithm, Germany)
- Vishwa Pal (Structured light, Optical computing, IIT Ropar)

6. Research and Labs

The Centre would establish four research labs:

- A state-of-the-art quantum optics laboratory
- A world class prototype fabrication facility
- Organic nanowire processing and in situ high resolution microscopy (Single quantum device testing & microfluidic cyber security and other chip design)
- Microwave, radiowave and infra-red physics laboratory

7. Mandates & Deliverables

The CQT will have following mandates and deliverables:

- Construction of a prototype facility for a quantum computer and cryptographic devices.
- Development of a reliable and scalable optical vortex-based quantum computing platform that can solves specific problems.
- Development and optimization nanowire self-assembly as encoding of quantum algorithms for the optical vortex-based quantum computer.

- Become an active partner in the National Mission on Quantum Technologies and Applications initiated by Govt of India.
- CQT will offer M.Tech and PhD degree programs and support minor/specialization for B.Tech programs
- CQT will conduct skill development activities to produce next-generation researchers, which include undergraduate students, postgraduate students, doctoral, postdoctoral, and faculty.
- Center will organize national-international conferences, competitions, seminars, workshops, and others such activities to promote knowledge and research culture.

8. Collaborations

Some of the Academic institutes and Industries in India and abroad with whom CCQT will collaborate include:

India:
IIT Mandi
IIT Kharagpur
IIT Ropar
PRL Ahmedabad

Abroad:
NIMS Japan
MTU USA
Engg. Commercial Inc, UK
Quant. Algorithm, Germany

9. Capacity Building

- **Skilled Manpower**

  Training of ~ 30 high quality Ph.D. and Postdoctoral researchers in five years Training of ~ 50 students every year during their M.Tech (Quantum Technology), M.Sc. (Physics) and B.Tech. program

- **Academic Programs**

  The CQT will support various teaching programs in the institute besides giving training to the students for their PhD, integrated PhD degrees. A new program *M.Tech. in Quantum Technologies* will be started which would train 100 students in five years. Additional specialization courses related to Quantum Technologies would be offered to the existing undergraduate and postgraduate program. Therefore, the CQT will cater to the need of following teaching programs:
  - Ph.D.
  - Integrated Ph.D.
  - M.Tech. in Quantum Technologies

- M.Sc. (Physics)
- B.Tech. (Engineering Physics)
- B.Tech (Computer Science)

10. Sustainability

CQT will require continuous support in the form of manpower and maintenance cost of the instruments. The priority would be given to generate financial support from government funding agency for the ongoing and new projects. Additionally, the facility will be made open to researchers from other institutes through collaborative mode or user charge basis. We would be generating a revenue of Rs. 50 lakh per year for the sustenance of the center. In general, following policies would be implemented for the long-term sustainability of the proposed research activity:

- Reasonable user charges for internal and external users. We plan to allot 30 % of time on the equipment to skilled users. We expect a revenue generation of ~10 lakh per year from the user charges.
- Quantum computing startups from IIT Mandi, as incubation will be integrated with our program providing certified parameter testing and fundraising.
- Generation of grant worth ~ More than 200 Cr in five years from various funding agencies
- Implementing 20% overhead charges on the research and consultancy projects for internal research groups.
- Tuition fee from the new academic M.Tech program in Quantum Technology.
- Periodic workshop and certification program for external and industry users.

ANNEXURE-E

Course No.: CY-001

Preparatory Chemistry – 1

L-T-P-C: 3-1-0-4

Students Intended for: Preparatory Students

Core or Elective: Core

Course Contents:

Physical Chemistry:

Kinetic Theory: Idea of distribution function, properties of gamma functions; transformation properties for Cartesian to polar coordinates. Maxwell's speed and energy Distributions (derivations for 1, 2 and 3 dimensions); distribution curves; different types of speeds and their significance, frequency of collisions against a surface; frequency of collisions against a surface; frequency of binary collisions; mean free path

Thermodynamics: System and Surroundings, walls; reversible and irreversible processes; isothermal, adiabatic and other processes; work, partial and total derivatives; exact differntials and state functions, definitions of thermodynamic functions: Zeroth Law (T), First law (U) and second law (S); other functions like H, A, and G. Carnot's cycle and theorems; changes of thermodynamic functions in irreversibility and entropy, importance of H in thermo-chemistry, Maxwell's relations.

Chemical Kinetics: Order and molecularity of reactions, first and second order reactions, average life period, concept of Arrhenius activation energy

Inorganic Chemistry: Periodicity, general trends, blocks of periodic table, s-block, p-block, and introduction to f-block, VSEPR, valence band theory, electron deficient bonding, thermodynamics of reduction processes.

Organic Chemistry: Classification and nomenclature of organic compounds, hybridization, dipole moment and bond energy, factors influencing electron availability: inductive effect, electromeric effect, resonance, mesomeric effect or conjugative effect, hyperconjugative effect, steric effect, H-bonding foirce etc, concept of organic acid and base, substitution and elimination reactions.

Text Books:

1. J. D. Lee, *Concise Inorganic Chemistry,* 5th Edition, ELBS, 1996.
2. R. T. Morrison and R.N. Boyd, *Organic Chemistry*, 5th Edition, Printice Hall of India Pvt. Ltd. 1990.
3. G. Solomons and C. Fryhle, *Organic Chemistry*, John Wiley and Sons (Asia) Pte Ltd.
4. D. A. McQuarrie, and J. D. Simons, *Physical Chemistry*, Viva Books, 1998.
5. Irving M. Klotz and Robert M. Rosenberg, *Chemical Thermodynamics*: Basic Concepts and Methods, Wiley, 2008.

Course No.: CY-002
Preparatory Chemistry – 2
L-T-P-C: 3-1-0-4
Students Intended for: Preparatory Students
Core or Elective: Core
Course Contents:

Physical Chemistry:

Quantum Mechanics: Construction of Hamiltonian operator; solution of $H\Psi=E\Psi$ for particle in a 1-d box; normalization and orthogonolity of Ψ, nodes in excited states, and calculation of average values like <x>, <x2>, <p> and <p2>, demonstration of the uncertainty product inequality, $\Delta x \Delta p \geq h/4\Pi$, discussion on uncertainty principle.

The H atom problem: Hamiltonian in Cartesian and Polar Coordinates; separation of radial and angular parts; emergence of magnetic quantum number; mathematical forms of orbital functions (ns and np) and degeneracy, shapes of orbitals (s,p).

Spectroscopy and Photochemistry: Einstein's Law, primary photophysical processes; potential energy diagram; Frank-Condon Principle; fluorescence and phosphorescence; photochemical reactions, quantum yield; photosensitisation; photochemical equilibrium; dimerization of anthracene.

Alkali-Metal Spectra (S, P, D, F series): its origin, multiplicity of spectral lines, idea of spin quantum number; physical idea of spin-orbit coupling, rotational (rigid rotator model) and vibrational (harmonic oscillator model) spectra of diatomics; frequency expressions, applications to estimate molecular parameters, idea of $n \rightarrow \Pi^*$ and $\Pi \rightarrow \Pi^*$ electronic spectra; conjugated polyenes and 1-d box model.

Dipole moment and Intermolecular Forces: Induced and orientation polarisation; Debye and Clausius Mossotti equations (with derivations), dipole-dipole, dipole-induced dipole and van der Walls ibnteractions in molecules, realistic intermolecular potential energy diagrams.

Inorganic Chemistry: Chemistry of d-block elements, crystal field theory, magnetism in transition metal compounds, valence bond theory for prediction of molecular geometry, magnetic properties, metal-carbonyl chemistry, important elements of catalysis by transition mnetal compounds, chemistry of f-block elements.

Organic Chemistry: Functional group inter-conversions, concept of stereochemistry concept of aromaticity, aromatic electrophilic and nucleophilic substitution reactions.

Text Books:

1. J. D. Lee, *Concise Inorganic Chemistry,* 5th Edition, ELBS, 1996.
2. R. T. Morrison and R.N. Boyd, *Organic Chemistry*, 5th Edition, Printice Hall of India Pvt. Ltd. 1990.
3. G. Solomons and C. Fryhle, *Organic Chemistry*, John Wiley and Sons (Asia) Pte Ltd.
4. P. W. Atkins, *Molecular Quantum Mechanics*, Oxford University Press, 1999.

Course No.: HS-001

Preparatory English – 1

L-T-P-C: 3-0-0-3

Students Intended for: Preparatory Students

Core or Elective: Core

Course Contents:

Introduction: Basic Grammar, Vocabulory [3 Lectures]

Grammar I: Tenses, Active-Passive, Parts of Speech [9 Lectures]

Sentence Construction: Types of Sentences, Common Errors, Indianisms, Faculty Connections [9 Lectures]

Reading Comprehension: Summarizing, Reading Short Fiction [9 Lectures]

Speaking Skills: Public Speaking and Group Discussions [9 Lectures]

Grammar II: Punctuations, Articles and Preposition [3 Lectures]

Reference Books:

1. Krishna Mohan and Meera Banerji, *Developing Communication Skills*, McMillan Co., 1990.
2. Raman, Meenakshi, and Sangeeta Sharma, *Technical Communicatio: Principles and Practice*, Oxford University Press, 2015.
3. Wren, P. C., and Martin, H., *English Grammar and Composition*, S. Chand and Company Ltrd., 2005.

Course No.: HS-002

Preparatory English – 2

L-T-P-C: 3-0-0-3

Students Intended for: Preparatory Students

Core or Elective: Core

Course Contents:

Introduction: Introduction to the Course [3 Lectures]

Reading: Reading Comprehension [3 Lectures]

Writing: Precise writing, Essay Writing, Report Writing, Writing for Scholarships, Formal Writing [15 Lectures]

Speaking: Group Discussion, Presentation (Level 2) [6Lectures]

Listening: Listening Skills [3 Lectures]

Communication: Barriers to Communication, Intercultural Communication [6 Lectures]

British English/Americal English: Differences between British and American English [3 Lectures]

Vocabulary: Vocabulary [3 Lectures]

Reference Books:

1. Krishna Mohan and Meera Banerji, *Developing Communication Skills*, McMillan Co., 1990.
2. Raman, Meenakshi, and Sangeeta Sharma, *Technical Communicatio: Principles and Practice*, Oxford University Press, 2015.
3. Internet Sources

Course No.: MA-001

Preparatory Mathematics – 1

L-T-P-C: 3-1-0-4

Students Intended for: Preparatory Students

Core or Elective: Core

Course Contents:

Basic Set Theory: Functions and their inverses, composition of functions, relations, equivalence relations, partitions [6 Lectures]

Number Systems: Numbers – natural numbers, integers, rationals, reals, complex, uncountability of reals, irrationality of 2 etc. Congruencies, Residue Classes, addition and multiplication modulo n etc. [8 Lectures]

Complex Numbers: Complex Numbers as ordered pairs. Argand's diagram. Triangle inequality. De Moivre's Theorem. [4 Lectures]

Algebra: Quadratic equations and expressions; permutations and combinations; Binomial theorem for positive integral index [4 Lectures]

Coordinate Geometry: Locus, Straight lines; Equations of circle, parabola, ellipse and hyperbola in standard forms; parametric representation [8 Lectures]

Vectors: Addition of vectors. Multiplication by a scalar; scalar product, cross product and scalar triple product with geometrical applications. [6 Lectures]

Matrices and Determinants: Algebra of matrices; Determinants and their properties; Inverse of a matrix; Cramer's rule. [6 Lectures]

Text Books:

1. S. Lang, *An Introduction to Linear Algebra,* undergraduate text in Mathematics, Springer Verlag.
2. Fred Safier, *Schaum's outline of Precalculus*, 2nd Edition, McGraw Hill, 2008.
3. S. L. Loney, *The elements of Coordinate Geometry*, Scholarly publishing office, University of Michigan Library, 2005.

Reference Books:

1. Murray R. Spiegel, *Schaum's Outlines of Vector Analysis* (and An Introduction to Tensor Analysis), McGraw Hill, 1968.
2. Murray R. Spiegel, *Schaum's Outlines: Complex Variables* (with An Introduction Conformal Mapping and its Applications), McGraw Hill, 1964.
3. R. K. Jain and S. R. K. Iyengar, *Advanced Engineering Mathematics*, 3rd Edition, Narosa Publisher.

Course No.: MA-002

Preparatory Mathematics – 2

L-T-P-C: 3-1-0-4

Students Intended for: Preparatory Students

Core or Elective: Core

Course Contents:

Functions and Their Graphs: Functions, Inverse Function, Elementary Function and their Graphs. [6 Lectures]

Differentiation: Limit, Continuity. Derivative and its geometrical significance. Derivatives of sum, difference, product and quotient of functions. Derivatives of polynomial, rational, trigonometric logarithmic and exponential functions. Differentiation of composite and implicit functions. [12 Lectures]

Applications of Derivatives: Tangents and normal. Increasing and decreasing functions. Maxima and Minima. [6 Lectures]

Integration and its Applications: Integration as the inverse process of differentiation. Integration by parts and by substitution. Definite ingeral and its application to determination of areas (simple areas). [8 Lectures]

Differential Equations: First order ordinary differential equations. Homogeneous and exact equations. First order linear equations.

Text Books:

1. G. B. Thomas and R. L. Finney, *Calculus and Analytical Geometry*, Addison Wesley / Narosa.
2. T. M. Apostal, *Calculus,* 2nd Edition, Wiley Eastern.

Reference Books:

1. R. K. Jain and S. R. K. Iyengar, *Advanced Engineering Mathematics*, 3rd Edition, Narosa Publisher.

Course No.: PH-001

Preparatory Physics – 1

L-T-P-C: 3-1-0-4

Students Intended for: Preparatory Students

Core or Elective: Core

Course Contents:

Units, Dimensions: Basic dimensional analysis and a consolidated information of units of various physical observables. [3 Lectures]

Vector Analysis: Vector multiplication and vector algebra, Vector analysis: gradient, divergence, and curl. Cartesian, cylindrical, plane polar and spherical polar coordinate system. [9 Lectures]

Concepts of Classical mechanics: Velocity, linear momentum, acceleration, forced, Newton's law of motion, work and energy, conversion laws for energy and momentum, centre of mass, collision, moment of a force, angular momentum, conservation of angular momentum, moment of inertia. [12 Lectures]

Laws of Gravity: Acceleration due to gravity, escape velocity, Kepler's laws of planetary motion. [6 Lectures]

Heat and Thermodynamics: Thermal equilibrium, concept of temperature, tehermometers and the Kelvin scale, heat, work, and internal energy. First law of thermodynamics. Second law of thermodynamics. . [6 Lectures]

Waves and Acoustics: Waves, propagating and stationary waves, interferenfe of waves, sound wave. . [6 Lectures]

Text Books:

1. D. Halliday, R. Resnick, and J. Walker, *Fundamentals of Physics*, John Wiley.
2. Sears and Zemansky's *University Physics with Modern Physics*, 13th Edition, Pearson.

Course No.: PH-002

Preparatory Physics – 2

L-T-P-C: 3-1-0-4

Students Intended for: Preparatory Students

Core or Elective: Core

Course Contents:

Electrostatics: Electric Charge, Coulomb's law, electric field and electric potential, electric field lines, electric dipole, Gauss' law, capacitors and capacitance, current, resistivity, Ohm's law, resistance in series and parallel, Kirchhoff's law. [9 Lectures]

Magnetism: Magnetism, magnetic field, Bio Savart's law, Ampere's law, Faraday's laws of induction, self and mutual inductance, LCR Circuit. [9 Lectures]

Optics: Reflection of light, spherical mirrors, mirror formula. Refraction of light, total internal reflection and its applications, lenses, thin lens formula, maginification power of a lenses, wave nature of light, Huygen's principle, interference, diffraction, Young's double slit experiment. [9 Lectures]

Modern Physics: Structure of the atom, Bohr's model, alpha, beta and gamm radiations, law of radioactive decay, half-life and mean life, blackbody radiation, Wien's law, Stefan's law, photoelectric effect, X-rays, Moseley's law, de Broglie wavelength of matter waves, ideas of quantum physics. [15 Lectures]

Text Books:

1. D. Halliday, R. Resnick, and J. Walker, *Fundamentals of Physics*, John Wiley.
2. Sears and Zemansky's *University Physics with Modern Physics*, 13th Edition, Pearson.