INDIAN INSTITUTE OF TECHNOLOGY MANDI
KAMAND, DISTT. MANDI – 175075 (HIMACHAL PRADESH)

MINUTES OF 41ST BOARD OF ACADEMICS MEETING

VENUE	:	A-4(SC) and GUEST HOUSE (NC) CONFERENCE ROOM + ONLINE
DATE	:	13TH AUGUST, 2021 (FRIDAY)
TIME	:	03:00 P.M.

Following members attended the meeting

Sl. No	Responsibilities	Name
1	Dean Academics	Dr. Rahul Vaish
2	Associate Dean (Research)	Prof. Chayan K Nandi
3	Associate Dean (Courses)	Dr. Srikant Srinivasan
4	Chairman Library Advisory Committee	Dr. Rajeshwari Dutt
5	Chairman Course Proposal Committee	Dr. Venkata Uday Kala
6	Course Coordinator (IC Courses)	Dr. Aniruddha Chakraborty
7	Course Coordinator (B.Tech.-CSE)	Dr. Dileep A D
8	Course Coordinator (B.Tech.-EE)	Dr. Rahul Shrestha
9	Course Coordinator (B.Tech.-CE)	Dr. Maheshreddy Gade
10	Course Coordinator (B.Tech.-DSE)	Dr. Manoj Thakur
11	Course Coordinator (B.Tech.-EP)	Dr. Pradeep Kumar (SBS)
12	Course Coordinator (B.Tech.-M.Tech. Integrated Dual Degree in Bio-Engg.)	Dr. Shubhajit Roy Chowdhury
13	Course Coordinator (M.Tech.-(Mechanical Engg. (Energy Systems)) (MES)	Dr. Rajeev Kumar
14	Course Coordinator (M.Tech.- (Energy Engg. (Materials)) (MEE)	Dr. Sumit Sinha Ray
15	Course Coordinator (M.Tech.-(Structural Engg.))	Dr. Sandip Kumar Saha
16	Course Coordinator (M.Tech.-(Fluid and Thermal Engg.))	Dr. Pradeep Kumar (SE)
17	Course Coordinator (M.Tech.-(VLSI))	Dr. Hitesh Shrimali
18	Course Coordinator (M.Tech.-(Power Electronics and Drives))	Dr. Narsa Reddy Tummuru
19	Course Coordinator (M.Tech.-(Communication and Signal Processing))	Dr. Siddartha Sarma
20	Course Coordinator (M.Tech.-(Computer Science and Engg.))	Dr. Sriram Kailasam
21	Course Coordinator M.Sc. (Chemistry)	Dr. Bhaskar Mondal
22	Course Coordinator (M.Sc.-Physics) + (I-Ph.D. (Physics))	Dr. Ajay Soni
23	Course Coordinator (MA Dev.Studies)	Dr. Shyamasree Dasgupta
24	Nominee-1: School of Computing & Electrical Engineering	Dr. Renu M Rameshan
25	Nominee-2: School of Computing & Electrical Engineering	Dr. Manas Thakur
26	Nominee-2: School of Basic Sciences	Dr. C. S. Yadav
27	Industry Member – 1	Dr. Nadeem Akhtar
28	Research Affairs Secretary	Mr. Adesh Singh
29	Academic Affairs Secretary	Mr. Bhumanyu Goyal
30	Assistant Registrar (Academics): Secretary	Mr. Vivek Tiwari

Following members could not attend the meeting

Sl. No.		Name	
1	Course Coordinator (HSS Courses)	Dr. Suman Sigroha	Member
2	Course Coordinator (B.Tech.-ME)	Dr. Gaurav Bhutani	Member
3	Course Coordinator (M.Tech.-Biotechnology)	Dr. Shyam K Masakapalli	Member
4	Course Coordinator (M.Sc.-Applied Mathematics)	Dr. Rajendra K Ray	Member
5	Nominee-1: School of Engineering	Dr. Gaurav Bhutani	Member
6	Nominee-2: School of Engineering	Dr. Subhamoy Sen	Member
7	Nominee-1: School of Basic Sciences	Dr. Nitu Kumari	Member
8	Nominee-1: School of Humanities & Social Sciences	Dr. Devika Sethi	Member
9	Nominee-2: School of Humanities & Social Sciences	Dr. Puran Singh	Member

PART-A

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

41.1 **Confirmation of the minutes of 40th meeting of Board of Academics:**
The minutes of the 40th Board of Academics meeting held on 11th May, 2021 were confirmed.

41.2 **To consider an increase in the maximum number of credits that may be registered in the Aug-Dec 2021 semester by the BTech 2019 and BTech 2020 batch:**

Dr. Srikant Srinivasan, Associate Dean (Courses) presented a proposal to the Board of Academics regarding increase in the maximum number of credits may be registered in the Aug-Dec 2021 semester by the BTech 2019 and BTech 2020 batch. After due deliberations, the BoA resolved that only those students with good academic standing and CGPA be allowed to register up to 26 credits in the Aug-Dec 2021 semester. Further, if the student is able to maintain SGPA of 8.0 with 26 credits of coursework, then the student may be allowed to pursue semester internship and continue registering for a maximum of 26 credits in the remaining semesters, so that they can complete their BTech program in a timely manner. For the BTech 2020 batch, the students may be allowed to register for 24 credits for the Aug-Dec 2021 semester and continue to register 24 credits per semester if they are able to maintain good SGPA.

BoA recommended the above for consideration of the Senate and its approval.

41.3 **To frame a uniform policy across the institute regarding the appropriate disciplinary action to be taken for cases of academic dishonesty by students:**

After brief discussion, it was decided to constitute a committee to formulate the policy. The recommendations of the committee may be presented to the BoA.

41.4 **Proposal of a Double Major B.Tech. degree:**

Dr. Maheshreddy Gade, presented a proposal to the Board of Academics regarding Double Major BTech Degree at the Institute. After due deliberations, the committee was requested to rework on the proposal and present the same in a subsequent BoA meeting.

41.5 **Minimum performance in M.Tech/MS (by Research)/Ph.D/I-PhD etc. programmes for continuation of Assistantship/Fellowship/Scholarship:**

Prof. Chayan K Nandi, Associate Dean (Research) presented a proposal for minimum performance in M.Tech./M.S. (by Research)/I-Ph.D./Ph.D. etc. programmes for continuation of Assistantship/Fellowship/Scholarship.

- Minimum CGPA requirements for continuation of Assistantship/ Fellowship in M.Tech/MS (by Res.)/PhD/I-PhD will be 6.5.
- Having CGPA less than 6.5, the student will be considered under probation.
- Student on probation will not be allocated TA duties and no fellowship will be given.
- The fellowship discontinued due to poor academic performance may be resumed only once the minimum CGPA of 6.5 is attained.

- Arrears will not be paid for the discontinued period.

After discussions, the BoA recommended it for consideration of the Senate and its approval.

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41.6 **To consider the One-Time relaxation for B.Tech.2018 admitted batch to undergo semester internship in their final semester:**

Dr. Srikant Srinivasan, Associate Dean (Courses) presented a proposal to the Board of Academics regarding One-Time relaxation for B.Tech 2018 admitted batch to undergo semester internship in their final semester.

According to the current rules, a semester internship is not allowed in the last semester. But a good number of companies, especially in Core EE and ME (and a few in CSE), are interested in hiring BTech students as interns in the 8th semester followed by immediate joining as full-time employees. Considering the fact that for batch '18, semester internships were allowed when the internship season was almost over, therefore, a one-time relaxation may be provided to them to take up semester internship during their final semester, only if the semester is in online mode.

After due deliberations, the BoA recommended the proposal for consideration of the Senate and its approval.

41.7 **Proposal on resolving the issue of registration of IC142 as a 4 credit course by B.Tech (2018-22) batch:**

Dr. Shubhajit Roy Chowdhury, Chairperson of the Committee presented a proposal to the Board of Academics regarding the issue of registration of IC 142 as a 4 credit course by B.Tech (2018-22) batch. After due deliberations, the BoA recommended the Option2 of the proposal i.e.

'The students may be given a waiver of 1 credit in the basket of free electives, which means they will have to complete 21 credits instead of 22 credits of free electives.'

The BoA recommended it to the Senate for consideration and approval.

41.8 **Proposal for B.Tech (Honours) degree to Integrated Dual Degree in Bioengineering programme students:**

Dr. Shubhajit Roy Chowdhury, Coordinator for B.Tech-M.Tech Integrated Dual Degree in Bioengineering programme presented a proposal to the Board of Academics regarding BTech (Honours) degree to Integrated Dual Degree in Bioengineering programme students.

After due deliberations, the BoA suggested modifications and deferred the proposal.

41.9 **To consider approval of courses presented by the Course Proposal Committee (CPC):**

(a) The Chairperson, Course Proposal Committee (CPC) presented courses in 36th -40th Board of Academics (BoA) meetings held during 30th September, 2020 to 25th March, 2021. The courses were further processed in accordance with the recently approved CPC process by the Senate. Accordingly, the BoA approved the following courses:

Sl. No.	Course No.	Course Title	Credits (L-T-P-C)
1	BE 203	Enzymology and Bioprocessing	2-0-2-3
2	BY 527	Gene silencing and genome editing: principles and applications	3-0-0-3
3	CE 403	Wastewater Engineering	3-0-0-3
4	CE 512	Advanced Soil Mechanics	3-0-0-3
5	CE 513	Advanced Foundation Engineering	3-0-0-3
6	CS 563	Scalable Data Science	3-1-0-4
7	CY 647	Organic Spectroscopy	3-0-0-3
8	EE 582	Nonlinear Analysis and Control of Power Electronic Converters	3-0-0-3
9	EE623P	Practicum on Digital Control of Power Electronics and Drives	1-0-4-3
10	EE 641	Next Generation Wireless Technologies	3-0-0-3
11	PH 604	Optical Properties of Solids	3-0-0-3
12	CS 550	Computer Graphics and Geometric Design	2-0-2-3
13	CS 611	Program Analysis	3-1-0-4
14	CS 662	Mobile Virtual Reality and Artificial Intelligence	3-0-0-3
15	EE 583	Smart Grids	3-0-0-3
16	EE 584	Power System Protection	3-0-0-3
17	EE 630	HVDC Transmission and Flexible AC Transmission Systems	3-0-0-3
18	EP 401P	Engineering of Instrumentation	1-0-5-4
19	EP 402P	Engineering Physics Practicum	1-0-5-4
20	PH 606	Quantum Field Theory	3-0-0-3
21	BE 301	Biomechanics	3-0-2-4
22	BE 303	Applied Biostatistics	3-0-2-4
23	BE 304	Bioinformatics	2-0-2-3
24	CE 561	The Science of Climate Change	3-0-0-3
25	CS 672	Advanced Topics in Deep Learning	3-0-2-4
26	EE 551	Applied Photonics for Scientists and Engineers	2-1-0-3
27	IC 131	Applied Chemistry for Engineers	2-0-2-3
28	EE 560	Reconfigurable Computing	3-0-2-4
29	ME 310*	System Dynamics and Controls	3-0-0-3
30	ME 501P	Practicum-I	0-0-6-3
31	ME 514	Fundamentals of Multiphase Flow	3-0-0-3
32	ME 516	Polymer Technology for Engineers	3-0-0-3
33	ME 627	Mesh Independent Computational Techniques	3-0-0-3
34	ME 628	Impact Mechanics	3-0-0-3
35	CS 514	Data Structures and Algorithms-II	3-0-2-4
36	CS 515	Advanced Computer Science Practicum	2-0-2-3
37	EP 302	Computational Methods for Engineering	2-0-2-3
38	EP 403	Physics of atoms and molecules	3-0-0-3
39	EE 528	Modelling and Analysis of Electrical Machines	2-0-2-3
40	ME 517	Advanced Analytical Techniques for Engineers	3-1-0-4
41	ME 518	Conduction and Radiation	3-0-0-3

*ME 310 will count towards the additional 3 Discipline Core credits for B.Tech. (Mechanical Engineering) that were created due to IC basket restructuring.

The final course descriptions after incorporating the suggested changes are placed at **Annexure - A**:

(b) The Chairperson, Course Proposal Committee (CPC) presented the following seventeen courses for consideration and approval of the BoA.

S.No.	Course No	Course Name	Credit	Distribution (L-T-P-C)	Remarks
1	BE302	Bioelectric Systems Modeling	4	3-0-2-4	
2	BE305	Bioethics and Regulatory Affairs	1	1-0-0-1	
3	BE501	Anatomy and Physiology	3	3-0-0-3	
4	BE503	Biosensing and Bioinstrumentation	4	3-0-2-4	
5	BE504	Biomaterials	4	3-0-2-4	
6	BE505	Computational Biology	3	2-0-2-3	
7	CS511	Applied Probability	2	2-0-0-2	
8	CS512	Matrix Theory	2	2-0-0-2	
9	CS513	Discrete Mathematics	4	3-1-0-4	
10	CS 551	Human Computer Interaction	3	3-0-0-3	
11	EN503	Energy Storage Technology	3	3-0-0-3	Revision of existing course
12	EE5XX	Power Quality Problems and Mitigation Techniques in Microgrids	3	3-0-0-3	
13	EN 509	Functional Materials for Energy Engineering	3	3-0-0-3	Revision of existing course
14	HS5xx	Epidemics in World History: From the Black Death to COVID-19	3	3-0-0-3	
15	ME518	Conduction and Radiation	3	3-0-0-3	
16	ME 519	Technical communication for Engineers	2	0-2-0-2	
17	??	Mechanics of Rigid Bodies	3	1.5-1.5-0-3	

After due deliberations, the BoA recommended modifications in the description of the courses.
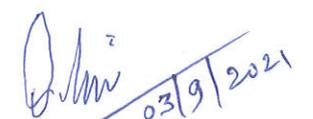
41.10 Any other item with the permission of the Chair.

-NIL-

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

03/9/2021
Secretary, Board of Academics

3/9/2021
Chairman, Board of Academics

PART-B

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

-NIL-

List of courses approved during 41st Board of Academics meeting held on 13th August, 2021

The Chairperson, CPC presented the following courses in the Board of Academics (BoA) meetings held during 30th September, 2020 to 25 March, 2021. After due deliberations, the Board of Academics approved the following courses during its 41st meeting held on 13th August, 2021:

1. **Courses recommended in 36th BoA meeting held on 30th September, 2020:**

Sl. No.	Course No.	Course Title	Credits (L-T-P-C)
1	BE 203	Enzymology and Bioprocessing	2-0-2-3
2	BY 527	Gene silencing and genome editing: principles and applications	3-0-0-3
3	CE 403	Wastewater Engineering	3-0-0-3
4	CE 512	Advanced Soil Mechanics	3-0-0-3
5	CE 513	Advanced Foundation Engineering	3-0-0-3
6	CS 563	Scalable Data Science	3-1-0-4
7	CY 647	Organic Spectroscopy	3-0-0-3
8	EE 582	Nonlinear Analysis and Control of Power Electronic Converters	3-0-0-3
9	EE623P	Practicum on Digital Control of Power Electronics and Drives	1-0-4-3
10	EE 641	Next Generation Wireless Technologies	3-0-0-3
11	PH 604	Optical Properties of Solids	3-0-0-3

2. **Courses recommended in 37th BoA meeting held on 29th October, 2020:**

Sl.No.	Course No.	Course Title	Credits (L-T-P-C)
1	CS 550	Computer Graphics and Geometric Design	2-0-2-3
2	CS 611	Program Analysis	3-1-0-4
3	CS 662	Mobile Virtual Reality and Artificial Intelligence	3-0-0-3
4	EE 583	Smart Grids	3-0-0-3
5	EE 584	Power System Protection	3-0-0-3
6	EE 630	HVDC Transmission and Flexible AC Transmission Systems	3-0-0-3
7	EP 401P	Engineering of Instrumentation	1-0-5-4
8	EP 402P	Engineering Physics Practicum	1-0-5-4
9	PH 606	Quantum Field Theory	3-0-0-3

3. **Courses recommended in 38th BoA meeting held on 22nd January, 2021:**

Sl. No.	Course No.	Course Title	Credits (L-T-P-C)
1	BE 301	Biomechanics	3-0-2-4
2	BE 303	Applied Biostatistics	3-0-2-4

3	BE 304	Bioinformatics	2-0-2-3
4	CE 561	The Science of Climate Change	3-0-0-3
5	CS 672	Advanced Topics in Deep Learning	3-0-2-4
6	EE 551	Applied Photonics for Scientists and Engineers	2-1-0-3
7	IC 131	Applied Chemistry for Engineers	2-0-2-3

4. **Courses recommended in 39th BoA meeting held on 25th March, 2021:**

Sl.No.	Course No.	Course Title	Credits (L-T-P-C)
1	EE 560	Reconfigurable Computing	3-0-2-4
2	ME 310*	System Dynamics and Controls	3-0-0-3
3	ME 501P	Practicum-I	0-0-6-3
4	ME 514	Fundamentals of Multiphase Flow	3-0-0-3
5	ME 516	Polymer Technology for Engineers	3-0-0-3
6	ME 627	Mesh Independent Computational Techniques	3-0-0-3
7	ME 628	Impact Mechanics	3-0-0-3

*ME 310 will count towards the additional 3 Discipline Core credits for B.Tech. (Mechanical Engineering) that were created due to IC basket restructuring.

5. **Courses recommended in 40th BoA meeting held on 11th May, 2021:**

Sl. No.	Course No.	Course Title	Credits (L-T-P-C)
1	CS 514	Data Structures and Algorithms-II	3-0-2-4
2	CS 515	Advanced Computer Science Practicum	2-0-2-3
3	EP 302	Computational Methods for Engineering	2-0-2-3
4	EP 403	Physics of atoms and molecules	3-0-0-3
5	EE 528	Modelling and Analysis of Electrical Machines	2-0-2-3
6	ME 517	Advanced Analytical Techniques for Engineers	3-1-0-4
7	ME 518	Conduction and Radiation	3-0-0-3

The description of the courses is placed below:

Course Number: BE 203
Course Name: Enzymology and Bioprocessing
Credits: 2-0-2-3
Prerequisites: IC136
Intended for: B. Tech M.Tech. Integrated Dual Degree Bioengineering students
Distribution: Core for Integrated Dual Degree Bioengineering students, elective for other B.Tech students

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1. **Preamble:**

   This course introduces the fundamentals of enzymology and cellular bioprocessing. The first part of the course introduces the fundamentals of enzyme catalysis and its kinetic analysis. The second part introduces bioprocessing principles and related parameters that would influence cellular growth kinetics in typical bioreactor operation conditions. The laboratory component will provide basic hands-on understanding of the enzyme kinetics and bioprocessing.

2. **Course Outline:**

Theory: **[28 hours]**
Module 1: Fundamentals of Enzymology   **[8 hours]**
Introduction to Enzymes, Classification of Enzymes, Specificity of Enzyme Action, The Fisher 'lock-and-key' hypothesis, The Koshland 'induced-fit' hypothesis
An Introduction to Bioenergetics, Catalysis and Kinetics, Kinetics of Single-Substrate Enzyme-Catalyzed Reactions, The Henri and Michaelis Menten Equation, The Briggs Haldane modification, The Lineweaver-Burk Plot, The Eadie Hofstee and Hanes Plot
Module 2: Enzyme Inhibition and Applications   **[6 hours]**
Reversible Inhibition: - Competitive Inhibition, Un-competitive Inhibition, Non-competitive Inhibition, Substrate Inhibition, Allosteric Inhibition and Irreversible Inhibition
Sigmoidal Kinetics and Allosteric Enzymes
Case studies pertaining to industrial enzyme(s)
Module 3: Introduction to Cellular Bioprocessing   **[8 hours]**
Bioprocessing – definition and introduction to control parameters in Bioprocessing such as dissolved oxygen, redox, pH, temperature etc.
Stoichiometry and Kinetics of cell cultivation – Quantitative description of cell growth and product formation, Kinetic Model of Cell Growth - Monod Model.
Bioreactor types and their Operating Modes – Batch, fed-batch and continuous
Module 4: Fermentation and Downstream Processing   **[6 hours]**
Fermentation technology and Downstream processing
Case studies on lab-scale bioprocessing of biochemicals

Lab: **[28 hours]**
- Enzyme kinetics –Activity analysis, Effect of substrate concentration, Effect of temperature, Effect of pH
- Process parameter control in Stirred tank Bioreactor, Microbial cultivation in a batch and estimation of growth rates, Fermentation and downstream analysis of end products

3. Text Books:

a. Trevor Palmer, Philip Bonner, "Enzymes", 2nd Edition, Woodhead Publishing, 2007.

b. Sarfaraz K. Niazi, Justin L. Brown, "Fundamentals of Modern Bioprocessing", 1st edition, CRC Press, 2017.

4. Reference Books:

a. Alejandro G. Marangoni, "Enzyme Kinetics: A Modern Approach", John Wiley & Sons, 2003.

b. Michael L. Shuler, Fikret Kargi, Matthew De Lisa, "Bioprocess Engineering: Basic Concepts", 3rd Edition, Prentice Hall, 2017.

5. Similarity content declaration with existing courses: None

Sl. No.	Course Code	Similarity Content	Approx. % of content
1	BY513	Cellular bioprocessing	20%

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

Approvals:
Other faculty interested in teaching this course: Dr. Amit Jaiswal

Proposed by: Dr. Shyam Kumar Masakapalli   School: SBS

Signature: Date:

Recommended/Not Recommended, with comments:

Chairman, CPC   Date:

Approved/Not approved

Chairman, Senate   Date:

Course Name	: Gene silencing and genome editing: principles and applications
Course Number	: BY527
Credits	: 3-0-0-3
Prerequisites	: IC136 or consent of the faculty member
Intended for	: UG (IDD Bioengg, 4th year) / M.Sc./M.Tech./ Ph.D.
Elective or Core	: Elective

Preamble: The main objective of this course is to introduce the concepts, developments and applications of gene silencing & genome editing technologies. This course provides a comprehensive understanding of RNAi mediated gene-silencing and CRISPR-Cas9 gene-editing technologies and potential applications to genetically modify organisms for commercial, agriculture, medical purposes. The students will learn how RNAi works, how it can be utilized to modulate gene expression and perform genetic screens in various model systems. Similarly, the students will learn discovery of CRISPR-Cas9 system, its mechanism and regulatory aspects of genome editing. As a result of this course, the students will have strong foundations and first-hand scientific understanding of current trends in gene silencing and genome editing.

Learning Outcome:

By the end of this course, students will be able to understand principles and mechanisms of RNAi and CRISPR-Cas9 technologies and their potential applications in biomedical research, agriculture, and healthcare industries. They will learn to use online tools to design RNAi (siRNAs) and CRISPR (sgRNA) constructs to knockdown and edit genes of interests. They will be able to design experiments to silence gene expression in various organisms and learn the ethical implications of genetic manipulation.

Course modules:

Module 1   *Introduction to gene structure and regulation*   **[6 hours]**
Basic principles of genome organizations, gene structure, chromatin structure, gene silencing by histone modifications, gene silencing by DNA methylation (epigenetics and genome imprinting). Eukaryotic gene structure, eukaryotic transcription, transcriptional gene silencing.

Module 2   *RNA biology*   **[6 hours]**
Post-transcriptional gene silencing. Introduction to RNAi (brief history and endogenous roles). Discovery of siRNAs and microRNAs. Molecular mechanisms RNAi. Genetic manipulations and RNAi in *C. elegans*, *Drosophila*, mammalian systems and plants.

Module 3   *Small silencing RNAs*   **[6 hours]**
Classification, biogenesis and gene-regulatory mechanisms of small RNAs. Cellular functions of small RNAs. Functions of small RNAs in developmental biology, diseases and agriculture. RNAi screens (reverse genetic screens) in cell culture and model organisms.

Module 4   *Applications of RNAi*   **[3 hours]**
RNAi-induced innate immunity and antiviral siRNAs. RNA-based therapeutics, vaccines and delivery of siRNAs. Examples of candidate RNAi drugs (Givosiran, Patisiran etc)

Module 5   *Genome editing methods-1*   **[6 hours]**

Transgenesis, site-specific chromosomal integration by Cre-LoxP, phiC31-integrase, and Mos1-transposon.

Module 6   *Genome editing methods-2*   **[6 hours]**

Genome engineering with TALENs and ZFNs. Discovery and mechanisms of CRISPR-Cas9 meditated genome editing. Different CRISPR systems and their uses in genome editing.

Module 7   **[3 hours]**

Designing of sgRNAs and repair templates. Next generation cloning technologies. Genome engineering methods for model organism. Construction of transgenics and knockouts using *C. elegans* model organism.

Module 8   *Applications of CRISPR mediated genome editing*   **[6 hours]**

Cas9 for gene regulation: CRISPR interference (CRISPRi), CRISPR activation (CRISPRa) and CRISPRon. Genome-wide CRISPR knockout screens. Applications in agriculture, food and fuel industry. Ethical concerns of genome editing by CRISPR.

Text books

1. Genome Engineering via CRISPR-Cas9 System. Edited by Vijai Singh, Pawan K. Dhar, 2020 Academic Press, ISBN 978-0-12-818140-9.
2. RNAi: A Guide to Gene Silencing. Edited by Gregory J. Hannon, 2003, Cold Spring Harbor Laboratory Press, ISBN 978-0879696412.

Reference Books

1. RNA Interference in Practice: Principles, Basics, and Methods for Gene Silencing in C. elegans, Drosophila, and Mammals. Edited by Ute Schepers, 2005, Wiley☐VCH Verlag GmbH, ISBN 978-3527310203.
2. MicroRNAs: From Basic Science to Disease Biology, Krishnarao Appasani, 2008, Cambridge University Press, ISBN 9780521865982.
3. Regulation of Gene Expression by Small RNAs. Edited by Rajesh K. Gaur, John J. Rossi. 2009, CRC Press, ISBN 978-1138111738.
4. Genome Editing and Engineering: From TALENs, ZFNs and CRISPRs to Molecular Surgery. Edited by Krishnarao Appasani, 2018, Cambridge University Press, ISBN 978-1-107-17037-7.
5. CRISPR-Cas: A Laboratory Manual. Edited by Jennifer Doudna, 2016, Cold Spring Harbor Laboratory Press, ISBN 978-1-621821-31-1.

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

Similarity Content Declaration with Existing Courses:

S.No.	Course code	Similarity content	Approx. % of content
1	Molecular Biotechnology (BY515)	Transcriptional Control of Gene Expression	< 10%

Justification for new course proposal if cumulative similarity content is > 30%: N.A.
Approvals:
Other Faculty who may be interested in teaching this course: *Dr. Prosenjit Mondal*

Proposed by Prasad Kasturi   School: SBS

Signature: _____   Date 30/09/2020

Recommended/Not Recommended, with Comments:

_____   Date: _____
Chairman, CPC
Approved / Not Approved

_____   Date: _____
Chairman, Senate

Course Number	: CE403
Course Name	: Wastewater Engineering
Credits	: 3-0-0-3
Prerequisites	: Environmental Science (IC 230)
Intended for	: UG/ M. Tech. /MS
Distribution	: Discipline Core

Preamble: The objective of this course is to help students in understanding different aspects of waste water treatment plant. The course will be helpful for the students to develop the ability to apply the understanding of the physical, chemical and biological phenomenon for an efficient design of sewage treatment plant. The course will also help them understand about the regular maintenance while operating the sewage treatment unit for sustainable recycling. The course also focuses on the advanced design constraint of wastewater treatment plant based on the feedback of the local climatic conditions. The expected outcome of the course is that the students will be able to develop and ability to estimate, design and maintain the sewage treatment plant.

Course Outline:

1. **Planning and hydraulic design of sewerage system**: Population forecasting of town, equivalent sewage flow estimation, onsite, decentralized and centralized systems, Sewer pipelines and the materials, sewers hydraulics, Storm drainage, Storm runoff estimation, sewer appurtenances, corrosion in sewers its prevention and control, sewage pumping, drainage in buildings, plumbing systems for drainage, wastewater Collection System, Instrumentation and automation techniques, .
(8 hours)

2. **Primary treatment Processes**: Unit Operations and Processes, Selection of treatment processes, Onsite sanitation, Septic tank, Grey water harvesting ,Primary treatment ,Principles, functions and design of sewage treatment units ,screens ,grit chamber, primary sedimentation tanks ,Construction, Operation and Maintenance aspects. (8 hours)

3. **Secondary treatment Processes**: Selection of Treatment Methods, Hydraulic Principles, Functions Activated Sludge Process and Extended aeration systems, Trickling filters and their design, Sequencing Batch Reactor(SBR), Membrane Bioreactor (MBR), Waste Stabilization Ponds, Reclamation and Reuse of sewage, Recent Advances in Sewage Treatment ,Construction, Operation and Maintenance aspects. (10 hours)

4. **Sewage Disposal, Recycle and Reuse**: Standards for Disposal Methods, dilution, Mass balance principle, Self-purification of river, Oxygen sag curve, deoxygenation and reaeration, Dissolved oxygen Modelling, Land disposal, Agriculture uses of treated Sewage, Cycle of emerging organic contaminant and their effects on human health, sodium hazards, Soil dispersion system. (10 hrs)

5. **Sludge and Solid Waste Management**: Sludge characterization, Thickening, Design of gravity thickener, Sludge digestion, Standard rate and High rate digester design, Biogas recovery, Sludge Conditioning and Dewatering, Sludge drying beds, ultimate residue disposal.   (6 hours)

Textbooks:

1. Metcalf, L., Eddy, H. P., & Tchobanoglous, G. (1979). Wastewater engineering: treatment, disposal, and reuse (Vol. 4). New York: McGraw-Hill.
2. Karia, G. L., & Christian, R. A. (2013). Wastewater treatment: Concepts and design approach. PHI Learning Pvt. Ltd..
3. Duggal K.N., "Elements of Environmental Engineering" S. Chand and Co. Ltd., New Delhi, 2014.
4. Mackenzie L. Davis, Ph.D., P.E., DEE,. Water and Wastewater Engineering: Design Principles and Practice, McGraw-Hill Education, 2010.

Reference Books/Journals:

1. Metcalf, Leonard, Harrison P. Eddy, and Georg Tchobanoglous. Wastewater engineering: treatment, disposal, and reuse. New York: McGraw-Hill, 1979.
2. Garg, S.K., Environmental Engineering Vol. II, Khanna Publishers, New Delhi, 2015.
3. Journal of Water Processing Engineering-Elsevier
4. Journal of Environmental Engineering-ASCE

6. **Similarity Content Declaration with Existing Courses**

S.N.	Course Code	Similarity Content	Approx. % of Content
1	CE 3XX (Wastewater Treatment)	Less than 5%	Less than 10%

Proposed by: Dr Deepak Swami   **School:** SE

Signature_____Date_____

Recommended/Not Recommended, with Comments:

_____   Date:_____

Chairman, CPC

Approved / Not Approved

_____   Date:_____

Chairman, Senate

Course Number: CE512
Course Name: Advanced Soil Mechanics
Credits: 3-0-0-3
Prerequisites: Geotechnical Engineering I (CE302) or Equivalent

Intended for: UG/PG
Distribution: Discipline Elective

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1. Preamble:

The underlying soil stratum being the basic support system for any civil engineering structure, it becomes imperative to understand the soil behavior in details. Soil being a three-phase complex system, its strength and deformation behavior significantly gets influenced by the flow of water through the soil medium and evolution of pore water pressure under applied loading. Keeping these aspects in focus, the proposed Advanced Soil Mechanics course will discuss steady state and transient flow through soil along with the stress state and stress-strain behavior of soil under different loading conditions. It will also include interpretation of different laboratory tests for estimation of shear strength of soil and various factors influencing its shear strength response.

2. Course Modules with Quantitative Lecture Hours:

Module 1: Steady State Flow through Soil (8 hours)
Laplace's Equation of Continuity; Permeability; Flow net, use and method of obtaining flow net; Numerical solution for 2D steady state flow in soil; Examples of 2D and 3D seepage in soil, seepage in anisotropic soil.

Module 2: Transient Flow in Soil (8 hours)
Compressibility and rate of consolidation; Primary, secondary and tertiary consolidation; Consolidation theories: Terzaghi and Biot's formulation, numerical solution of governing consolidation equation; Laboratory consolidation test and its interpretation.

Module 3: Strength and Deformation Behavior of Soil (11 hours)
Introduction to stress-strain behavior of soils, principal stresses, Mohr diagrams; Shear strength of cohesive and cohesionless soils, various failure criteria, drained and undrained shear strength of soils; Determination of shear strength from various laboratory tests, e.g. direct shear, triaxial, simple shear, true triaxial, hollow cylinder test, interpretation of various triaxial test results, significance of pore pressure parameters; Concept of critical void ratio; Dilation in sands.

Module 4: Stress Path Pertaining to Various Loading Conditions (4 hours)
Stress path, drained and undrained stress path; Stress path with respect to different initial state of the soil; Stress path for different practical situations.

Module 5: Critical State Concept (11 hours)

Critical state soil mechanics, concept of soil yielding, critical state parameters; Critical state for normally consolidated and over consolidated soil; Significance of Roscoe and Hvorslev state boundary surface, drained and undrained plane, complete state boundary surface.

3. Text Book:

(i) Muni Budhu, Soil Mechanics and Foundations, John Wiley & Sons, Inc., 2010.

(ii) T.W. Lambe and R.V. Whitman, Soil Mechanics, John Wiley & Sons, 1991.

4. References:

(i) Jonathan Knappett and R.F. Craig, Craig's Soil Mechanics, CRC Press, 2012.

(ii) B.M. Das, Advanced Soil Mechanics, CRC Press, 2013.

(iii) James K. Mitchell, Kenichi Soga, Fundamentals of Soil Behavior, John Wiley & Sons, 2005.

(iv) J.H. Atkinson, The Mechanics of Soils and Foundations, CRC Press, 2007.

(v) Holtz, R. D., and Kovacs, W. D., An Introduction of Geotechnical Engineering, Prentice Hall, 1981.

(vi) Parry, R. H. G., Mohr Circles, Stress Paths and Geotechnics, CRC Press, 2004.

(vii) David Muir Wood, Soil Behaviour and Critical State Soil Mechanics, Cambridge University Press, 1991.

(viii) Andrew Schofield and Peter Wroth, Critical State Soil Mechanics, McGraw Hill, 1968.

(ix) Potts, D.M. and Zdravkovic, L., Finite Element Analysis in Geotechnical Engineering: Theory, Thomas Telford, USA, 1999.

5. Similarity Content Declaration with Existing Courses:

Sl. No.	Course Code	Similarity Content	Approximate % of Content
1	CE301 Geotechnical Engineering	Introductory concepts of Seepage, Consolidation and Shear Strength	<20%
2	CE606 Constitutive Modeling of Frictional Material	Concepts of stress-strain behavior of soils	<5%

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

Not Applicable.

Approvals:

Other faculty interested in teaching this course: Dr. Kala Venkata Uday and Dr. Ashutosh Kumar.

Proposed by: Dr. Mousumi Mukherjee   School: School of Engineering (SE)

Signature: *Mousumi Mukherjee*   Date: 30/09/2020

Recommended / Not Recommended, with comments:

_____

Chairman, CPC   Date:

Approved / Not Approved

_____

Chairman, Senate   Date:

Course Number: CE513
Course Name: Advanced Foundation Engineering
Credits: 3-0-0-3
Prerequisites: Geotechnical Engineering II (CE402) or Equivalent

Intended for: UG/PG
Distribution: Discipline Elective

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1. Preamble:

Any civil engineering structure requires a foundation to transfer the superstructure load safely to the underlying soil. In this regard, it is important to estimate the bearing capacity of the soil and settlement of the foundation under the applied load. The proposed course discusses various bearing capacity theories for both shallow and deep foundations in details and it includes special scenarios like foundations resting on layered soil and sloping ground etc. It also deals with the estimation of settlement of such foundations and associated design principles.

2. Course Modules with Quantitative Lecture Hours:

Module 1: Bearing Capacity Theories for Shallow Foundation **(4 hours)**
Foundation classification, choice of foundations; Field investigations, soil data and design parameters; Bearing capacity theories, influence of water table, soil compressibility, inclined loading, one-way and two-way eccentricity on the bearing capacity of soil.

Module 2: Bearing Capacity for Special Cases **(4 hours)**
Bearing capacity for special cases of shallow foundations: foundations resting on layered soil, foundations supported by a soil with rigid base, foundations on sloping ground, closely placed foundations.

Module 3: Allowable Bearing Capacity and Settlement of Foundations **(5 hours)**
Vertical stress increase in a soil mass caused by different types of foundation load; Elastic settlement of foundations, settlement of sandy soil: use of strain influence factor and field test data; Consolidation settlement; Allowable bearing capacity from field load test; Rigid and flexible foundations, contact pressure and settlement distribution beneath footings; Construction issues such as dewatering methods and underpinning of shallow foundations; Foundations on difficult soil: collapsible soils, expansive soils, and sanitary landfills.

Module 4: Mat Foundations **(7 hours)**
Combined footings, mat/raft foundation; Bearing capacity and settlement of mat foundation; Design of mat foundation: rigid and flexible methods; Buoyancy raft or floating foundation; Skirted foundation.

Module 5: Pile Foundations (**18 hours**)

Deep foundations; Load transfer mechanism for pile foundation, estimation of pile capacity, settlement of pile; Small strain and large strain dynamic tests in piles; Pile foundation design subjected to compressive load, uplift, lateral load; Design of pile groups; Pile raft; Concept of negative skin friction; Construction issues related to pile foundation, effect of adjacent constructions on existing pile foundation.

Module 6: Other Types of Deep Foundations (**4 hours**)

Well foundations, classification, physical characteristics: shape, size, scour depth, components of well foundations, allowable bearing pressure, forces acting on well foundation and its lateral stability; An introduction to caisson foundation: mechanism, type and construction.

3. Text Book:

(iii) B.M. Das, Principles of Foundation Engineering, Cengage Learning, 2013.

(iv) N.N. Som and S.C. Das, Theory and Practice of Foundation Design, Prentice-Hall of India Pvt.Ltd, 2004.

4. References:

(x) Joseph Bowles, Foundation Analysis and Design, McGraw Hill Education, 2017.

(xi) J.H. Atkinson, The Mechanics of Soils and Foundations, CRC Press, 2007.

(xii) Muni Budhu, Soil Mechanics and Foundations, John Wiley & Sons, Inc., 2010.

(xiii) B.M. Das, Shallow Foundations: Bearing Capacity and Settlement, CRC Press, 2019.

(xiv) Michael Tomlinson and John Woodward, Pile Design and Construction Practice, CRC Press, 2014.

5. Similarity Content Declaration with Existing Courses:

Sl. No.	Course Code	Similarity Content	Approximate % of Content
1	CE402	Basic concept of bearing capacity, settlement and introduction to different types of foundations	<25%

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

Not Applicable.

Approvals:

Other faculty interested in teaching this course: Dr. Kala Venkata Uday and Dr. Ashutosh Kumar.

Proposed by: Dr. Mousumi Mukherjee   School: School of Engineering (SE)

Signature: *Mousumi Mukherjee*   Date: 30/09/2020

Recommended / Not Recommended, with comments:

_____
Chairman, CPC   Date:

Approved / Not Approved

_____
Chairman, Senate   Date:

Course Name: Scalable Data Science

Course Number: CS-563

Credits: 3-1-0-4

Prerequisite: Data Structures and Algorithms (CS202), Probability, Statistics and Random Processes (IC210), Algorithm Design and Analysis (CS403).

Students intended for: B.Tech.(3rd/4th year)/M.S./Ph.D.

Elective or Core: Elective.

Preamble: Recent advancements of the WWW, IoT, social networks, e-commerce, etc. have generated a large volume of data. Algorithms that help in gaining insights in order to make wiser decisions in large data sets are ubiquitous in several applications. Many naive algorithmic techniques may not be able to cope up with such a large volume of data by: a) running out of memory, and b) having a large running time. This course attempts to address these challenges by a) offering scalable algorithms, b) reducing the size of the data set such that the result of an algorithm on the reduced datasets is very close to its result on the original dataset. Algorithms covered in the course fit well in the intersection between theory and practice, and have guarantees on their accuracy and efficiency, and can be easily implemented.

Learning outcome: Topics covered in the course are fundamental subroutines (or sub-problems) that are required to build large scale systems. After taking this course, students will become familiar with their classical as well as state-of-the-art algorithms. They will have a theoretical understanding of the algorithms along with their practical implementation.

Course Modules:

1. **Dimensionality reduction algorithms:** Johnson-Lindenstrauss Lemma; Random Projections; Spectral Projection, and their applications [5].   (4 hours)

2. **Sketching algorithms for large data stream:** Reservoir sampling; Frequent element detection – Misra Gries algorithm; probabilistic counting – Flajolet and Martin Sketch; Set membership problem – Bloom filters and Cuckoo filters; Frequency estimation– Count Min- Sketching [8, 5].   (7 hours)

3. **Algorithm for large scale search:** Introduction to Locality Sensitive Hashing (LSH) and its variants: LSH for Jaccard Similarity – Minwise Independent Permutations (MinHash) [6] and its recent advancements (b-bit MinHash [14], One Permutation Hashing [15]); LSH for Cosine Similarity – Signed Random Projections (SimHash) [7]; LSH for Euclidean Distance [12]; LSH for Hamming distance [10].   (8 hours)

4. **Application of LSH:** Faster duplicate detection, clustering the web, large scale itemset mining, model compression. (3 hours)

5. **Mining massive graphs and applications:** Algorithms for page rank; community detection; finding overlapping communities and connected components; partitioning of graphs; counting triangles. Learning embedding of nodes with applications in link prediction, node classification. (7 hours)

6. **Clustering algorithms for large data:** Sampling algorithms for k- means clustering – k-means++ [1], scalable k-means++ [2]; spherical k-means clustering [9]; k-mode clustering [11]; spectral clustering [5]. (6 hours)

7. **Miscellaneous Topics:** Learning representation of text – word2vec [16, 13] and images – spectral hashing [17, 5] and its connection with Matrix Factorization; Topic modelling and Topic labelling [4, 3]; Building Recommendation System – a) Collaborative Filtering, b) Content based recommendation. (7 hours)

Similarity Content Declaration with Existing Courses: Following consists of a comparison between the proposed course and existing courses CS-561 (MapReduce and Big Data) and CS-660 (Data Mining and Decision Making).

1. CS-561 is more of a hands-on course which provides a thorough understanding of the MapReduce paradigm, and implementation of various algorithms on Big data platforms. However, scope of the proposed course is different and focuses on developing simple and practice algorithms with provable performance guarantees for several fundamental data science problems.
2. There are some intersections between the CS-660 and the proposed course on topics such as: a) Clustering, b) Principal Component Analysis, c) Association Rules. The intersection is less than 20%. Furthermore, the approach of covering these topics in CS-660 is different as compared to the proposed course. For these topics heuristics are covered in CS-660, while in the proposed course algorithms with provable guarantee on their accuracy and efficiency will be covered.

Proposed by: Rameshwar Pratap   **School:** SCEE

Text Books

[i] Anand Rajaraman, Jure Leskovec, and Jeffrey D. Ullman. Mining Massive Datasets. 2014.

[ii] A. Blum, J. Hopcroft and R. Kannan, Foundations of Data Science, Cambridge University Press,   2020.

References

[1] David Arthur and Sergei Vassilvitskii. k-means++: the advantages of careful seeding. In Proceedings of the Eighteenth Annual ACM- SIAM Symposium on Discrete Algorithms, SODA 2007, New Orleans, Louisiana, USA, January 7-9, 2007, pages 1027–1035, 2007.

[2] Bahman Bahmani, Benjamin Moseley, Andrea Vattani, Ravi Kumar, and Sergei Vassilvitskii. Scalable k-means++. PVLDB, 5(7):622–633, 2012.

[3] Shraey Bhatia, Jey Han Lau, and Timothy Baldwin. Automatic labeling of topics with neural embeddings. In COLING 2016, 26th International Conference on Computational Linguistics, Proceedings of the Conference: Technical Papers, December 11-16, 2016, Osaka, Japan, pages 953–963, 2016.

[4] D.M. Blei, A.Y. Ng, and M.I. Jordan. Latent Dirichlet allocation. the Journal of Machine Learning research, 3:993–1022, 2003.

[5] Avrim Blum, John Hopcroft, and Ravindran Kannan. Foundations of data science, 2015.

[6] Andrei Z. Broder, Moses Charikar, Alan M. Frieze, and Michael Mitzenmacher. Min-wise independent permutations (extended abstract). In Proceedings of the Thirtieth Annual ACM Symposium on the Theory of Computing, Dallas, Texas, USA, May 23-26, 1998, pages 327–336, 1998.

[7] Moses Charikar. Similarity estimation techniques from rounding algorithms. In Proceedings on 34th Annual ACM Symposium on Theory of Computing, May 19-21, 2002, Montréal, Québec, Canada, pages 380– 388, 2002.

[8] Graham Cormode. Sketch techniques for approximate query processing. In Synopses for Approximate Query Processing: Samples, Histograms, Wavelets and Sketches, Foundations and Trends in Databases. NOW publishers, 2011.

[9] Inderjit S. Dhillon and Dharmendra S. Modha. Concept decompositions for large sparse text data using clustering. Machine Learning, 42(1/2):143–175, 2001.

[10] Aristides Gionis, Piotr Indyk, and Rajeev Motwani. Similarity search in high dimensions via hashing. In VLDB'99, Proceedings of 25th International Conference on Very Large Data Bases, September 7-10, 1999, Edinburgh, Scotland, UK, pages 518–529, 1999.

[11] Zhexue Huang. Extensions to the k-means algorithm for clustering large data sets with categorical values. Data Mining and Knowledge Discovery, 2(3):283–304, Sep 1998.

[12] Piotr Indyk and Rajeev Motwani. Approximate nearest neighbors: Towards removing the curse of dimensionality. In Proceedings of the Thirtieth Annual ACM Symposium on the Theory of Computing, Dallas, Texas, USA, May 23-26, 1998, pages 604–613, 1998.

[13] Omer Levy and Yoav Goldberg. Neural word embedding as implicit matrix factorization. In Advances in Neural Information Processing Systems 27: Annual Conference on Neural Information Processing Systems 2014, December 8-13 2014, Montreal, Quebec, Canada, pages 2177–2185, 2014.

[14] Ping Li and Arnd Christian König. b-bit minwise hashing. In Proceedings of the 19th International Conference on World Wide Web, WWW 2010, Raleigh, North Carolina, USA, April 26-30, 2010, pages 671–680, 2010.

[15] Ping Li, Art B. Owen, and Cun-Hui Zhang. One permutation hashing. In Advances in Neural Information Processing Systems 25: 26th Annual Conference on Neural Information Processing Systems 2012. Proceedings of a meeting held December 3-6, 2012, Lake Tahoe, Nevada, United States, pages 3122–3130, 2012.

[16] Tomas Mikolov, Ilya Sutskever, Kai Chen, Gregory S. Corrado, and Jeffrey Dean. Distributed representations of words and phrases and their compositionality. In Advances in Neural Information Processing Systems 26: 27th Annual Conference on Neural Information Processing Systems 2013. Proceedings of a meeting held December 5-8, 2013, Lake Tahoe, Nevada, United States, pages 3111–3119, 2013.

[17] Yair Weiss, Antonio Torralba, and Rob Fergus. Spectral hashing. In D. Koller, D. Schuurmans, Y. Bengio, and L. Bottou, editors, Advances in Neural Information Processing Systems 21, pages 1753–1760. Curran Associates, Inc., 2009.
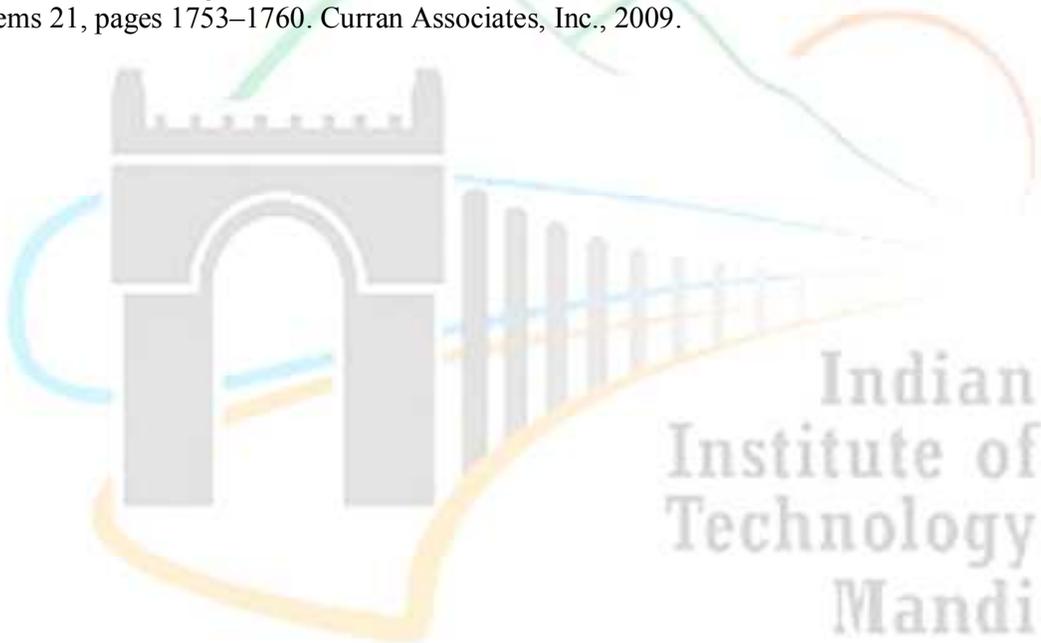
IIT Mandi
Proposal for a New Course

Course Title : **Organic Spectroscopy**
Course Number : **CY 647**
Credits : **3-0-0-3**
Prerequisites :
Intended for : **MSc Chemistry and PhD** (any discipline)
Distribution : **Elective Course**
Preamble:

The main objective of this course is to teach fundamental principles of various spectroscopic techniques used for structural elucidation of organic compounds. Along with the fundamental aspects, the focus will be given on problem solving which can help students from research perspective.

Modules:

1. UV Spectroscopy   (4 Hrs)

Introduction, Principle of UV spectroscopy, Concept of chromophore, Solvent effect, Fluorescence and phosphorescence, Characteristic absorption of organic compounds, Woodward-Fieser rules for dienes and enones, Substituent effects, Model compound studies.

3. Infra-red (IR) Spectroscopy   (4 Hrs)

Introduction, Molecular vibrations, factors influencing molecular frequencies, Infrared spectrometer, application of IR spectroscopy for identification of functional groups.

2. Mass Spectroscopy   (4 Hrs)

Basic principle, Ionization methods, Determination of molecular weight and molecular formula, Molecular ion and its recognition, Fragmentation and rearrangements, Examples of organic compounds from different classes such as hydrocarbon, hydroxy compounds, ketones, aldehydes, carboxylic acids and esters, lactones, amines and amides, nitro compounds, nitriles and heteroaromatic compounds

4. ^{1}H NMR Spectroscopy   (12 Hrs)

The NMR Phenomenon, Theory of nuclear magnetic resonance, Chemical shift and factors affecting chemical shift, integral and integration in proton NMR, Chemical equivalence and magnetic equivalence, First order and second order spectra, Spin-spin coupling, Pascal's triangle, Coupling constant, Factors influencing coupling constant, A_2, AB, and AX spin systems, AMX, ABX and ABC spin system with three coupling constants, D_2O exchange, Shift reagents, Effect of chiral center, ^{19}F and ^{31}P NMR, Structure elucidation of organic compound using ^{1}H NMR.

4. ^{13}C NMR Spectroscopy and 2-D NMR spectroscopy   (10 Hrs)

Introduction, Correlation chart for ^{13}C chemical shift, Proton-coupled ^{13}C spectra, Proton-decoupled ^{13}C spectra, carbon-deuterium coupling, NOE effects, Structural applications of ^{13}C NMR, Fundamentals and applications of DEPT technique in NMR spectroscopy, Application of 2-D NMR spectroscopic techniques such as ^{1}H-^{1}H COSY, ^{1}H-^{13}C COSY, HMBC and HSQC for structure determination of complex organic compounds.

5. Structural Elucidation of Organic Compounds   (8 Hrs)

Interpretation of spectroscopic data of unknown compounds, Application of UV-Vis, MS, IR and NMR spectroscopic techniques for solving structure of organic molecules

Textbooks:

1. NMR Spectroscopy 2nd Edition, Harald Gunther, Wiley Publishers.
2. Modern NMR Spectroscopy: A workbook of Chemical Problems 2nd Edition, Jeremy K.M. Sanders, Edwin C. Constable, Brian K. Hunter and Clive M. Pearce Oxford University Press.
3. Organic Structure Determination, using 2-D NMR Spectroscopy, a problem-based approach, Jeffrey H. Simpson

References:

1. Structure Determination of Organic Compounds, Tables of Spectral Data, Erno Pretsch, Philippe Buhlmann, Martin Badertscher, Springer.
2. Spectrometric Identification of Organic Compounds, Robert M. Silverstein, Francis X. Webster, David Kiemle, John Wiley & Sons; 7th Edition edition.
3. Organic Spectroscopy 3rd Edition, William Kemp, Palgrave Publishers Ltd

Approvals:

Other Faculty interested in teaching this course: Dr. Amit B. Pawar

Proposed by: Dr. Subrata Ghosh, School of Basic Sciences, IIT Mandi.

Signature_____Date_____--------------------

Recommended/Not Recommended, with Comments:
_____ Date:_____

Chairman, CPC Approved / Not Approved

Course number: EE 582
Course Name: Nonlinear Analysis and Control of Power Electronic Converters
Credit: L-T-P-C: 3-0-0-3
Prerequisite: Control Systems (EE301) & Power Electronics (EE 309)
Intended for: UG/PG
Elective/Core: Elective
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1. **Preamble:** Power electronic converters exhibit a variety of nonlinear phenomena due to the presence of switching elements, control loop, etc. This course deals with different mathematical tools to analyze those phenomena. Also, a few nonlinear control techniques are covered in this course to improve the transient performance compared to the linear controllers.

2. Course Modules with quantitative lecture hours:

Module 1: Introduction [6 hours]
Introduction to nonlinear models, nonlinear phenomena, common nonlinearities, qualitative behavior of linear systems, phase portraits, limit cycle oscillation, Jacobi linearization, direct method and indirect method of Lyapunov

Module 2: Sources of Nonlinearities in Power Electronic Converters [3 hours]
Nonlinearity due to switch and reactive components, nonlinearity introduced by the closed loop control, nonlinear phenomena observed in power electronic converters

Module 3: Control techniques for power electronic converters:
Voltage mode control, current mode control, PWM of type 1 and type 2, hysteresis control, sliding mode control, digital control, time optimal control [7 hours]

Module 4: Dynamic Modeling Techniques [4 hours]
Average modelling of PWM converters, limitations of average model, Discrete-time 1-D and 2-D models

Module 5: Stability Analysis [7 hours]
Basics of bifurcation theory and chaos, bifurcation of smooth and piecewise-smooth maps, nonstandard bifurcation in discontinuous maps, techniques of experimental investigations

Module: 6 Describing Function Analysis of Power Electronic Converters [7 hours]
Basics of describing function, describing function of different nonlinearities, stability analysis of limit cycle using Nyquist criteria

Module: 7 Simulation Study [7 hours]
Matlab based project work on i) Analysis of instability introduced by the different nonlinear components, ii) Nonlinear controller design to improve transient performance and stability boundary.

3. **Text books:**

S. Banerjee and G. C. Verghese, Eds*., Nonlinear Phenomena in Power Electronics: Attractors, Bifurcations, Chaos, and Nonlinear Control*. New York: IEEE Press, 2001.

4. **References:**

I. H. K. Khalil, *Nonlinear Control*, Pearson Education**,** 2015

II. C. K. Tse*, Complex Behavior of Switching Power Converters*. New York: CRC, 2003.

III. N. Mohan, T. M. Undeland, and W. P. Robbins, *Power Electronics Converters, Applications, and Design*, 3rd ed., Wiley India, 2008

IV. R. W. Erickson and D. Maksimovic, *Fundamentals of Power Electronics*, 2nd ed. Dordrecht, The Netherlands: Kluwer, 2001.

V. L. Corradini, R. Zane, D. Maksimović, P. Mattavelli, *Digital Control of High-Frequency Switched-Mode Power Converters*, John Wiley & Sons, 2015

5. **Similarity content declaration with existing courses:** less than 17% (module 1 and some portion of module 4)
   (i) Switch Mode Power Conversion (EE504)
   (ii) Nonlinear systems: stability and control (EE 515)

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

Approvals:
Other Faculty interested in teaching this course: -

Proposed by: Dr. Amit Kumar Singha   School: SCEE
Signature: Date:

Recommended/Not Recommended, with Comments:

_____   Date:_____
Chairman, CPC
Approved / Not Approved

_____   Date:_____
Chairman, Senate

Course Number: EE623P
Course Name: Practicum on Digital Control of Power Electronics and Drives
Credits: 1-0-4-3
Prerequisites: Switch Mode Power Conversion (EE504), Fundamentals of Electric Drives (EE508), Analysis and Design of Power Electronic Converters (EE527)
Intended for: PG/UG
Distribution: Core for M. Tech (PED), Elective for UG and other PG courses

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1. Preamble: Practicum on Digital Control of Power Electronics and Drives is a lecture + laboratory course designed to provide the students with a hands-on experience on practical implementation of digital control of power electronic converters and motor drives using microcontroller/Field Programmable Gate Array (FPGA). This course will help the students to explore the benefits and challenges of implementing digital control.

2. Course Modules with Quantitative Lecture Hours: This course has an hour of lecture session accompanied by four hours of laboratory session per week. List of course modules and experiments are provided below.

I.   Introduction to digital control, microprocessor/FPGA   **(5+20 hours)**
     Lecture: Why digital control, challenges in digital platform, fixed-point and floating-point representations, sampling, mathematical modelling of sampling, quantization and its impact on stability, s-domain to z-domain mapping (tustin, forward difference, backward difference), stability analysis in z-domain, discretization of analog controllers.
     Laboratory: Implementation of various building blocks (ADC sampling, PWM block, controller block) required for closed-loop control of power electronic converters (using C/Verilog coding).

II. Closed-loop control of DC-DC converters   **(5+20 hours)**
     Lecture: Controller design techniques, discretization of analog controllers, different types of delays introduced by the digital controllers.
     Laboratory: Implementation of digital voltage mode control, load transient performance, soft start-up, anti-windup arrangement.

III. **Lecture:** Digital Proportional-Resonant and Proportional Integral controller design for a single-phase and a three-phase voltage source inverter
     Laboratory: Implementation of a single-phase voltage source inverter with different loads (standalone case), digital controller design and implementation of different modulation techniques in a three-phase voltage source converter **(2+8 hours)**

IV. **Lecture:** Design of a digital controller in a buck fed DC motor
     Laboratory: Digital implementation of closed-loop control   **(1+4 hours)**

V.   **Lecture:** Digital V/F controller design in an induction machine
     Laboratory: Implementation of digital V/F control

                                                                              (1+4 hours)

3. **Textbooks:**

B. C. Kuo, *Digital Control Systems*, Oxford University Press, 2012

N. Mohan, T. M. Undeland, and W. P. Robbins, *Power Electronics Converters, Applications, and Design*, 3rd ed., Wiley India, 2008

4. References:

S. N. Vukosavic, *Digital Control of Electrical Drives,* springer, 2017

R. W. Erickson and D. Maksimovic, *Fundamentals of Power Electronics*, 2nd ed. Dordrecht, The Netherlands: Kluwer, 2001.

Similarity Content Declaration with Existing Courses: N/A
Justification for new course proposal if cumulative similarity content is >30%: N/A
Approvals:

Other faculty interested in teaching this course: Dr. Himanshu Misra

Proposed By: Dr. Amit Kumar Singha

Signature:

Recommended/Not Recommended, with comments:

_____Chairman, CPC

Approved/Not Approved
_____
Chairman, Senate
School: SCEE
Date:

Course Name: Advance Wireless Technologies
Course Number: EE641
Credits: 3-0-0-3
Prerequisites: EE304, EE503.
Intended for: UG and PG.
Distribution: Discipline elective for 3rd/ 4th year B.Tech. (CSE and EE)/ MS/ M.Tech./ PhD
and free elective for other branches.

Preamble:
This course will introduce various next generation wireless technologies to the students. The objective
of the course is to help students to analyze, compare and verify the performance and suitability of the
recent and upcoming wireless technologies. A firm understanding of the fundamentals of these next
generation wireless technologies will motivate the students to take up challenging projects/ research
problems in the related fields.

Learning outcome:
After taking this course, students will

1. be familiar with the upcoming wireless technologies of the next generation networks.
2. develop an intuitive understanding of various key wireless technologies unique to 5G networks.

3. get an analytical and conceptual understanding of the wireless technologies.
4. learn to analyze the performance of various aspects of the next generation wireless techniques, and
   conduct simulations to corroborate the analytical results.

5. The course will expose the students to the challenges in the next generation wireless technologies
   and hence will provide a platform to do cutting edge research.

Modules:
Introduction: (7 lecture hours) Challenges of next generation wireless networks. Basics of wireless
communications, multipath propagation and fading nature of wireless channel, BER. Performance of
multi-antenna wireless systems, precoding and power allocation for multi-user MIMO systems.

Cognitive Radio Systems: (5 lecture hours) Concepts, challenges of Software Defined Radio (SDR),
spectrum-sensing techniques, optimal power allocation, Interference suppression, and robust detection.

Massive MIMO Systems: (7 lecture hours) Introduction and challenges. Signal processing with perfect
& imperfect channel state information, rate scaling, performance of multi-cell massive MIMO systems
and spatial modulation.

mmWave/THz Wireless Systems: (6 lecture hours) Introduction, properties and modeling of wireless
channels, analog, digital and hybrid processing, sparse processing, channel estimation, optimal
precoders and combiners.

Cooperative Wireless Communication: (6 lecture hours) Introduction to cooperative communication and cooperation protocols (AF, DF, and SDF). Performance analysis of DF for MIMO and multi-relay wireless systems.

Non-Orthogonal Multiple-Access (NOMA): (6 lecture hours) Introduction, system model and decoding for NOMA systems. Outage probability, opt. performance, average rate, key aspects of uplink and downlink NOMA systems.

Full-Duplex Wireless Technology: (5 lecture hours) Introduction, self-interference and resulting performance. Optimal signal processing, power allocation and performance of FD Systems.

Optional topics:

Molecular Communication, Backscatter Communication, Energy Harvesting, Low Power Wide-area Networks (LPWA), Long Range Wireless Transfer (LoRa), D2D, Distributed MIMO, Physical layer caching and Physical layer security.

Key Text books:

1. Luo, Fa-Long and Zhang, Charlie (Jianzhong), Luo, Fa-Long, *Signal processing for 5G: algorithms and implementations,* Wiley-IEEE Press, 2017.

2. Wei Xiang, Kan Zheng, Xuemin - 5G Mobile Communications, Springer, 2017.

Key Reference Material:

1. Wong V., Schober, R., Ng, D., & Wang, L. (Eds.), *Key Technologies for 5G Wireless Systems*. Cambridge, 2017.

2. Dahlman, E., Parkvall, S., & Sköld, J., *5G NR: The next generation wireless access technology*. Elsevier 2018.

3. A. Chockalingam, B. S. Rajan, *Large MIMO Systems*, Cambridge, 2014.

4. Liu, K., Sadek, A., Su, W., & Kwasinski, A, *Cooperative Communications and Networking*. Cambridge University Press, 2008.

5. Tho Le-Ngoc, Ahmed Masmoudi, *Full-Duplex Wireless Communications Systems*, Springer, 2017.

6. Biglieri, Ezio, Andrea J. Goldsmith, Larry J. Greenstein, Narayan B. Mandayam and Herve Vincent, *Principles of Cognitive.* Cambridge, 2012.

7. N. Farsad, H. B. Yilmaz, A. Eckford, C. Chae and W. Guo, "A Comprehensive Survey of Recent Advancements in Molecular Communication," in *IEEE Communications Surveys & Tutorials*, vol. 18, no. 3, pp. 1887-1919, 2016.

Content Similarity Declaration with Existing Courses: N/A

Sr #	Course code	Similarity content	Approx. % of content
1	EE517: Wireless Communication and Networking	Basics of wireless communications, multipath propagation and fading nature of wireless channel, BER. Performance of multi-antenna wireless systems.	21 %

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

Approvals:
Other Faculty who may be interested in teaching/co-teaching this course:

Dr. Samar Agnihotri
Dr. Satyajit Thakor
Dr. Gopi Shrikanth Reddy

Proposed by Dr. Adarsh Patel **School**: SCEE

Signature:

Date

Recommended/Not Recommended, with Comments:

Date: Chairman, CPC

Approved / Not Approved

Date: Chairman, Senate

Course Name	: **Optical Properties of Solids**
Course Number	: PH 604
Credits	: (3-0-0-3)

Prerequisites : Mathematical Physics (PH511) or Mathematics-2 (EP301), Quantum Mechanics (PH513) or Quantum Mechanics and Applications (PH301), Electromagnetic Theory (PH521) or Foundation of electrodynamics (IC221), Condensed Matter Physics (PH523) or Solid State Physics (PH501)

Intended for Distribution: Elective

Semester : Odd/Even

Preamble : The study of optical properties of solids is very important to understand optoelectronics technology in the 21st century. The objective of this course is to know about the classical and the quantum theory of light-matter interactions, optical properties of low dimensional materials and the nonlinear optical effects in solids.

Course Outline : The course is focused on the optical properties of several classes of materials. It starts with the classical description of optical processes taking place in solids. Subsequently, it covers the treatment of absorption and luminescence by quantum theory, and the excitonic effects. The optical phenomena of semiconductors and metals are covered with emphasis on quantum structures. The course also includes discussion about the effect of phonons on optical properties. Finally, a brief introduction to nonlinear optical properties is introduced.

Modules:

Introduction: Optical processes, the complex refractive index and dielectric constant, quantum theory of radiative transition. [3]

Propagation of light in solid: Phenomenological models-Drude and Lorentz models. quantum mechanical description, linear response functions and Kramers–Kronig relations, dispersion, birefringence, optical anisotropy. [4]

Absorption of light: Interband transitions, transition rate, absorption in direct and indirect semiconductor, spin-orbit coupling, indirect gaps, Urbach tails, Landau levels, Franz-Keldysh effect, and absorption spectra. [3]

Excitons: Frenkel vs. Wannier excitons, optical selection rules, effect of Coulomb interaction on interband absorption, Franck-Condon approximation, Huang-Rhys model, Wannier exciton – LO phonon bound states. [3]

Luminescence: Emission from solids, Interband luminescence, photo and electro luminescence, photoluminescence spectroscopy. [3]

Quantum structures: Low dimensional materials and their electronic structures, absorption of quantum well, quantum confined Stark-effect, photoluminescence, optical properties of quantum dots, recent advancement in confined optical materials like zero and two-dimensional materials. [6]

Plasmonic systems: Metals, doped semiconductors, free carrier absorption and plasmons, surface and slab plasmons, plasmons in metallic particles, negative refraction. [3]

Light-phonon interactions: Infrared and Raman active phonons, Phonons absorption and reflectivity, polaritons, polarons, inelastic light scattering (Raman and Brillouin scattering), Feynman diagrams for light scattering. [4]

Impurity centers in semiconductors: Electronic spectrum of shallow donors, multiple valleys, valley-orbit coupling and acceptors, pseudospin-orbit coupling, impurity bands and metal-insulator transition, localized vibrational modes, LO modes bound to neutral impurities, lattice dynamics of isoelectronic impurities and mixed crystals. [5]

Nonlinear optics: optical nonlinearities, second order nonlinearities, third-order nonlinearties, optical Kerr effect, stimulated Raman scattering, generation and detection of terahertz radiation and recent advancement in this field. [6]

Books:

Text
1. Optical Properties of Solids by Mark Fox, Oxford University Press (2010)

References
1. Optical Processes of Solids by Yutaka Toyozawa, Oxford University Press (2010)
2. Optical Properties of Solids by Frederick Wooten, Academic Press (2013)
3. Solid State Physics Part II Optical Properties of Solids by M. S. Dresselhaus (2001).

Online resources: No

Similarity Content Declaration with Existing Courses:

Sl. No.	Course code	Similarity content	Percentage
1	PH 502 Photonics	Absorption and dispersion	<2%
2	PH 523 Condensed Matter Physics	Bound State and optical transitions in semiconductors	< 5%

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

Approvals*:*
Other Faculty interested in teaching this course: Dr. Pradeep Kumar (SBS)

Proposed by: Dr. Suman Kalyan Pal **School:** School of Basic Sciences (SBS)

Signature: Date:

Recommended/Not Recommended, with Comments:

_____   Date:_____
Chairman, CPC

Approved / Not Approved

_____   Date:_____

Chairman, Senate

IIT Mandi
Proposal for a New Course

Course Name: Computer Graphics and Geometric Design

Course Number: CS550

Credits: 2-0-2-3

Prerequisites: IC111 Linear Algebra or similar course, IC250 Data Structure and Algorithms or similar course.

Intended for: B.Tech. (CSE, EE and ME) II/III/IV year/ MS/M.Tech /PhD (any branch)

Distribution: Elective for B.Tech. II/III/IV year/ MS/M.Tech/PhD

Preamble: This course is intended to introduce the graphics processing pipeline found in modern day computers. This pipeline has three main phases. Depending on the application domain, the first phase creates 2D/3D modeling data which is in either discrete or continuous format. The second phase converts this data into simpler discrete primitive forms such as points, line-segments and triangles. The final phase maps this data onto the pixels of the computer display. Topics from all the three phases will be discussed. The course will include assignments about using popular graphics software suites as well as programming assignments.

Learning outcome: After taking this course, students will
1. be familiar with the graphics processing pipeline.
2. understand in depth, the set of fundamental algorithms which drive modern graphics engines.
3. be able to choose between alternative graphics/geometry data-structures which best suit the target application.
4. get hands-on experience with graphics programming APIs such as OpenGL.
5. get familiarity with using 3D graphics software packages such as Blender.
6. be able to create realistic scenes and environments.
7. be able to choose between alternative light sources and object materials in order to achieve the desired visual effect.
8. be able to use design kernels such as Open Cascade for solid modeling.
9. be able to design simple video games.

Course modules:

1. *Introduction:*   (2 hours)
   Motivation; Use of computer graphics in different domains; Digital display technologies; Color; Graphics processing pipeline; OpenGL.

2. *Geometry representation:*   (2 hours)
   Lines, triangles, polygons, meshes, point-clouds, polynomials, B-splines; Parametric v/s. implicit representation, boundary representation, volumetric representation.

3. *Rasterization:*   (6 hours)
   World and camera transformations; Orthogonal and perspective projections; Hidden-

surface removal, Z-buffering; Bresenham's line drawing algorithm; Triangle drawing primitive; Flood-fill algorithm.

4. *Lighting, shaders and texture mapping:* (6 hours)
    Radiometric concepts such as BRDF, BTDF, BSSRDF; Types of light sources such as point, spot, parallel; Texture mapping; Shading schemes such as Flat, Gouraud, Phong; Flattening of 3D surfaces; Bump maps, Normal maps, Displacement maps.

5. *Ray tracing and ray casting:* (3 hours)
    Mechanism of tracing the path of light in order to generate realistic images from 3D scenes.

6. *Modeling with curves:* (5 hours)
    Differential geometry of planar and space curves; Definition and basic properties of Bezier and B-spline curves; Weierstrass approximation theorem.

7. *Modeling with surfaces:* (4hours)
    Differential geometry of surfaces; Definition and basic properties of tensor-product Bezier surfaces.

Lab exercises:
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 shall be appropriately sequenced for synchronization with the laboratory.
Lab1: Installation of Blender, familiarization of the GUI, simple exercises involving creation of primitive shapes. Installation of OpenGL, writing a 'Hello World' application. Draw a few parametric as well as implicitly defined curves.
Lab2-4: Implementation of Bresenham's line drawing algorithm. Implementation of flood-fill algorithm.
Lab5-7: Create a 3D scene in Blender and apply various models of light-interaction such as BRDF, BTDF, BSSRDF. Insert different types of light sources into the scene. Apply textures to 3D objects. Lighting and shading in OpenGL, Raytracing
Lab8-10: Implementation of ray-tracing.
Lab11-12: Installation of Open Cascade. Construct and plot Bezier curves. Plot the tangents and osculating circles at a few points. Plot the Frenet frame at a few sampled points. Construct and plot B-spline curves.
Lab13-14: Construct and plot tensor-product Bezier surfaces. Plot tangent-plane and curvature at sampled points. Extract iso-curves.

Textbooks:
1. Donald D. Hearn *et al., Computer Graphics with OpenGL,* 3rd edition, Pearson, 2013

Reference Books:

1. Steve Marschner et al., *Fundamentals of Computer Graphics,* 4th Edition, A K Peters/CRC Press, 2015

2. Gerald Farin, *Curves and Surfaces for CAGD,* 5th Edition, 2001

3. Dave Shreiner, OpenGL Programming Guide: The Official Guide to Learning OpenGL, Versions 3.0 and 3.1 (7th Edition)

Proposal for a New Course

Content Similarity Declaration with Existing Courses: N/A

Sr #	Course code	Similarity content	Approx. % of content
1	CS451	Linear transforms, RGB space	5%

Justification for new course proposal if cumulative similarity content is > 30%: N.A.
Approvals:
Other Faculty who may be interested in teaching this course:
Proposed by Jinesh Machchhar   School: SCEE

Signature: _____   Date_____

Recommended/Not Recommended, with Comments:

_____ Date: _____
Chairman, CPC
Approved / Not Approved

_____ Date: _____
Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course number	:	CS611
Course name	:	Program Analysis
Credits	:	3-1-0-4
Prerequisites	:	CS202: Data Structures and Algorithms or equivalent; CS208: Mathematical Foundations of Computer Science or equivalent; CS304: Formal Languages and Automata Theory or equivalent
Intended for	:	B.Tech., M.Tech., MS, PhD
Distribution	:	Discipline Elective for BTech CSE, Elective for others

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1. Preamble

Program analysis approximates the runtime behavior of a program by looking at its source code. The results of program analyses are used to drive a plethora of applications: performance-oriented optimizations, program understanding, verification, debugging, refactoring, finding vulnerabilities, test generation, parallelization, and so on. As a result, once an exclusive part of the back-end of optimizing compilers, now program analysis finds its applications in the development of a large number of tools in a programming language's ecosystem. The aim of this course is threefold: (i) to develop a thorough understanding of the theory behind the long studied discipline of analyzing programs; (ii) to explore modern strategies that balance the trade-offs between the precision of an analysis and the resources consumed therein; and (iii) to get introduced to various applications that benefit from the results of a precise-yet-efficient program analysis.

2. Learning outcomes

After taking this course, the students will:
- have a strong foundation in abstract interpretation, which is a way to soundly approximate the semantics of a computer program;
- have a thorough understanding of the various dimensions along which the precision of an analysis can be varied and the associated trade-offs;
- be able to make intelligent decisions concerning the abstraction used to represent program features and the data structures used to implement static analyses, with an understanding of the corresponding effects on analysis precision and efficiency;
- be able to appreciate the challenges imposed by various features of programming languages on designing the associated compiler technology;
- have hands-on experience with some of the modern tools and frameworks used to implement program analyses in production and research environments; and
- be excited to use program analyses to improve different aspects of a program and the overall programming language ecosystem.

3. Course modules

- *Introduction to static analysis.* Concrete versus abstract semantics. Abstract interpretation. Galois connection. Symbolic execution. Control-flow graphs. Iterative dataflow analysis. Lattices and monotonicity. Analysis dimensions.   **[10 hours]**

- *Heap analysis.* Heap modeling. Points-to information. Andersen's and Steensgard's pointer analyses. Variations: alias analysis, null-check analysis, escape analysis.   **[9 hours]**

- *Interprocedural analysis.* Call-graph construction. Context sensitivity: functional and call-string approaches. Various context abstractions: value and lsrv contexts, object and type sensitivity. Heap cloning.   **[10 hours]**

- *Strategies for efficiency.* Demand-driven analysis. Program slicing. Analysis staging. Partial analysis. Efficient data structures. Heuristics and machine learning.   **[9 hours]**

- *Language features and challenges.* Lexical and dynamic scoping. Eager and lazy evaluation. Call-backs and reflection. Concurrency and synchronization: may-happen-in-parallel analysis. Speculative optimizations and deoptimization. Dynamic analysis.   **[10 hours]**

- *Sneak peek into applications.* Type checking. Bug detection. Program correctness. Program synthesis and repair. Software refactoring.   **[8 hours]**

4. Tutorials and assignments

This course involves hands-on practice with writing different program analyses, implementing the techniques for efficiency, and learning various associated tools and language features. The classes will teach the theory, and tutorials would train the students on the various skill-sets required to finish take-home programming assignments.

It may be noted that as the course covers several recent topics related to designing analyses that are precise-yet-efficient, the classes will use one or two important analyses as running examples (examples being alias analysis and pointer analysis for resolving virtual calls). Hence, another aim of the tutorial hours would be to help students imbibe the concepts learnt by making them write specifications of different analyses and optimization strategies.

The take-home assignments will be based on implementing and understanding (a) intra- and inter-procedural analyses; (b) strategies for imparting efficiency; (c) examples of handling tricky language features; and (d) non-trivial applications such as parallelization, refactoring and security.

5. References

1. Flemming Nielson, Hanne Riis Nielson and Chris Hankin. "Principles of Program Analysis", Corrected Edition, Springer, 1999.
2. Uday P. Khedker, Amitabha Sanyal and Bageshri Karkare. "Data Flow Analysis: Theory and Practice", First Edition, CRC Press, 2009.
3. Y. N. Srikant and Priti Shankar. "The Compiler Design Handbook", Second Edition, CRC Press, 2007.
4. Various research papers related to the course content.

6. Similarity content declaration with existing courses: <10% (CS502 Compiler Design: Control-flow graphs, iterative dataflow analysis, type checking.)

7. Justification of new course proposal if cumulative similarity content is >30%: N/A
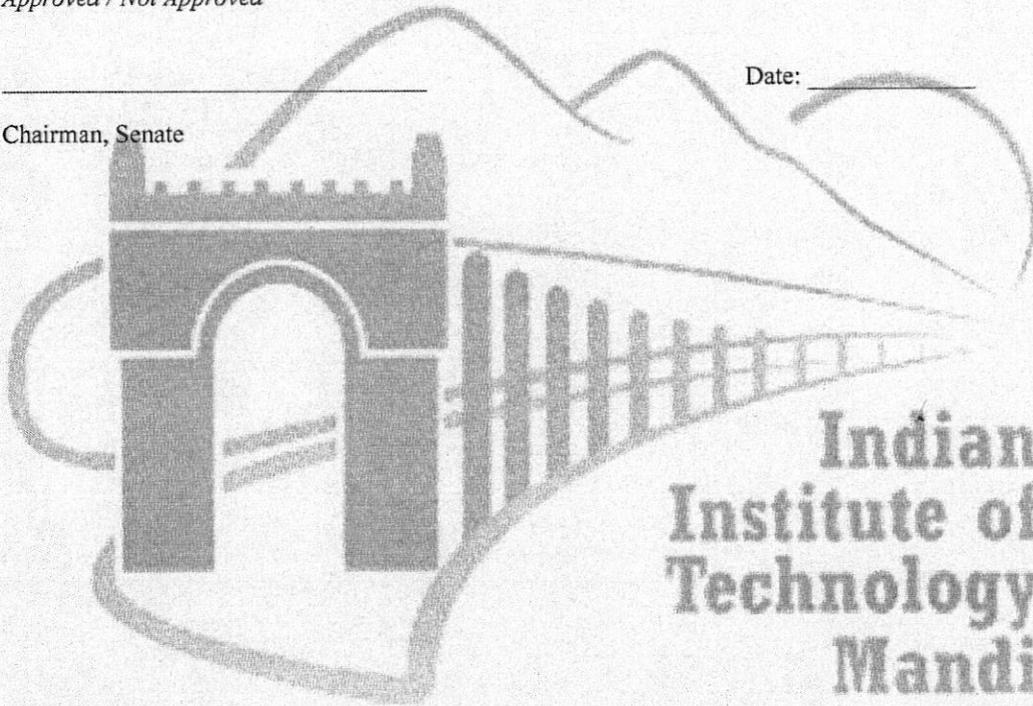
Proposal for a New Course

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number   : CS662

Course Name   : Mobile Virtual Reality and Artificial Intelligence

Credits   : 3-0-0-3

Prerequisites   : CS 660, CS 669, or an equivalent course in AI/ML area

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

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1. Preamble:

The virtual reality (VR) industry is growing rapidly with applications in several domains. VR applications are revolutionizing how human-beings interact with computers and a number of companies in the human-computer interaction area are at the forefront of this technology with VR products. Although VR application development in industry is gaining popularity, finding human resource with VR skills is a challenge. This course addresses this challenge by training interested students in mobile VR application development that involves AI in VR. The primary objectives of this course include the following: To give students hands-on exposure to mobile virtual reality; to give students experience with basic AI in virtual reality; and, to provide students with fundamentals of application design in virtual reality. The course will use tools such as Unity to provide hands on experience to the students and the students will gain exposure to such tools.

2. Course modules with quantitative lecture hours:

Modules

Module 1: Introduction to VR and VR programming   (12 hours)
Introduction to VR and its historical perspective (e.g., Sensorama simulator or Ivan Sutherland's Sword of Damocles), Introduction to software tools for VR, Moving a Cube, Lights, Particle Systems, Applying Physics, and Assets, VR Coding Introduction, Variables, Methods, If Blocks, Loops, Hello Mammoth, User Interaction, Inputs Introduction Preview, Key Presses, Moving a Player, Jumping, Moving Forward, Cycling Cameras, Prefabs Introduction, Instantiating Objects, Random Angles, Destroying Objects, Explosion Effects, Adding Explosion Effects.

Module 2: Building the first AI simulation   (6 hours)
Developing a Pathfinding Game, How to Set Up a Project, Node, String Map, A* Algorithm Setup, A* Algorithm Loop, Auxiliary Methods, Finishing the Algorithm, Importing 2D Assets, Building a Level, From Console to Visual, Adding Tanks, Identifying Nodes, Moving the Tank, Visually Moving Tank, Smooth Movement, Smooth Rotation, Ordering Tank to Move, Speeding up Player, Spawning Logic, Crate Visuals, Adding Crates to Valid Positions, Collecting Crates, Score Counting, Game Interface, Starting the Game, Game Over Screen, Scoring, Sounds.

Module 3: Introduction to Virtual Reality and Blending   (8 hours)
VR Introduction, Camera Changing Position, Triggering Events Interface, Blending and Introduction & Customizing Settings, Controlling Blender Camera, Emulate Numpad Camera, Manipulating Objects, Common Tools, Mirroring 1 Side of Object. Case Study: Flappy bird game in VR, First person shooter VR game, Kart VR game.

Module 4: Introduction to ML in VR　　　　　　　　　　　　(6 hours)

Introduction to Machine Learning, the need for ML in VR, different kinds of learnings, Neural Networks (NNs), Training a NN, Optimizer, Convolutional layers, Transfer learning, Imitation learning. Case study: Training the kart in kart game via IL and testing the kart drive.

Module 5: Reinforcement Learning　　　　　　　　　　　　(10 hours)

Introduction to Reinforcement Learning, Initial state, Training a policy, The PPO algorithm, Evolutional Strategies, Reward. Case study: Training a kart in the kart game with RL, Tensorboard analysis, Testing results.

3. Textbook:

Buttfield-Addison, P., Manning, J., Nugent, T. (2019). *Unity Game Development Cookbook: Essentials for Every Game.* O'Reilly Media.

4. Reference books:

Linowes, J., & Schoen, M. (2016). *Cardboard VR Projects for Android.* Packt Publishing Ltd.

Lanham, M. (2019). *Hands-On Deep Learning for Games: Leverage the power of neural networks and reinforcement learning to build intelligent games.* Packt Publishing Ltd.

Aversa, D., Kyaw, A. S., & Peters, C. (2018). *Unity Artificial Intelligence Programming: Add powerful, believable, and fun AI entities in your game with the power of Unity 2018!.* Packt Publishing Ltd.

4. Similarity Content declaration with existing courses:

S.No	Course Code	Similarity Content	Approximate %. Of Content
NA	NA	NA	NA

5. Justification for new course proposal if cumulative similarity content is >30%

N.A.

Approvals:

Other faculty interested in teaching this course

Proposed by:　　Dr. Varun Dutt　　　　　　　　School: SCEE

Signature: _____　　　　　　　　Date: 4th Jan 2021

Recommended/Not Recommended, with comments:

_____　　　　　　　　　　　　Date:

Chairman, CPC_____
Approved/Not Approved

_____　　　　　　　　　　　　Date:

Chairman, Senate

IIT Mandi
Proposal for a New Course

Course Number: EE583

Course Name: Smart Grids

Credits: 3-0-0-3

Prerequisites: EE-303 (Power systems)

Intended for: UG/PG

Distribution: Elective for B. Tech (EE), M.S., M. Tech. & Ph.D.

Preamble: The proposed course is designed to provide the concepts of modern power system operations and the challenges associated with them. The focus of the course is to enable the students acquire knowledge on smart grids which includes different architectural designs, sensors, measurement technology, renewable energy sources and storage integration.

Course Outline: This course provides overview of fundamentals, design tools, current research, and the critical issues in the development and deployment of smart grids. The application of smart grid technologies in different types of power sectors such as power generation, transmission and distribution will be taught with discussion on its applicability and advantages to the Indian power grid. The course will also emphasize on renewable energy source integration in present grids and explore issues in operation, analysis, management, control, protection and monitoring. In addition, there will be focus on sensing, metering and communication of smart grid data with cyber security aspects.

Course Modules with Quantitative lecture hours:

Introduction – 3 hours
Smart Grid: Concept, architecture, standards and protocols, Smart Grid in Indian Grid context.

Power System Operations – 6 hours
Load flow for smart grids, voltage stability assessment, and state estimation

Communication Infrastructure – 4 hours
Communication standards, requirements for data links, data quality, cyber security: state of the art, risks and mitigation

Wide Area Measurement Systems (WAMS) – 3 hours
Phasor measurement units (PMU), WAMS architecture, applications of WAMS for power system operation improvement: advantages and disadvantages

Integration of Renewable Energy Sources and Energy storage – 8 hours
Renewable energy sources, penetration and variability issues, environmental implications, demand response, electric vehicles, energy storage techniques: battery, pumped hydro, modelling of storage devices.

Smart Devices – 5 hours
FACTS, STATCOM, HVDC, fault current limiters

Protection and Security – 5 hours
Intelligent protection, contingency analysis and classification, security, outage management, remedial action schemes, special protections schemes

Meters and Sensors – 4 hours
Hardware, demand side integration, communication standards and protocols, smart meters, automatic meter reading (AMR), advanced metering infrastructure (AMI)

Microgrids – 3 hours
System operation, consumer energy management

Hardware in Loop (HIL) testing – 1 hours
HIL requirements, advantages and disadvantages.

Text book:
1. S. F. Bush, *Smart Grid: Communication-enabled intelligence for the electric power grid*, John Wiley and Sons, Ltd., 2014.
2. I. S. Jha, S. Sen, R. Kumar, D. P. Kothari, *Smart Grid Fundamentals & Applications*, New Age International Publishers, 2019.

References:
1. J. Momoh, *Smart Grid: Fundamentals of design and analysis*, John Wiley and Sons, Ltd., 2012.
2. B. M. Buchholz, Z. Styczynski, *Smart Grids – Fundamentals and Technologies in Electricity Networks*, Springer, 2014.
3. C. W. Jennings, *The Smart Grid: Enabling Energy Efficiency and Demand Response*, Fairmont Press Inc., 2009.
4. N. Hatziargyriou, *Microgrids: Architectures and Control*, John Wiley and Sons, Ltd., 2014.

Similarity Content Declaration with Existing Courses:

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	EE603	Renewable energy sources, penetration and variability issues,	6

Proposed by: **Pratim Kundu**   School of Computing and Electrical Engineering

IIT Mandi
Proposal for a New Course

Course Number: EE584
Course Name: Power System Protection
Credits: 3-0-0-3
Prerequisites: EE-303 (Power systems)
Intended for: UG/PG
Distribution: Elective for B. Tech (EE), M.S., M. Tech. & Ph.D.

Preamble: The proposed course is designed to provide the basic concepts of power system protection. System protection deals with detection of proximity of system to unstable operating region and consequent control actions to restore stable operating point and/or prevent damage to equipment. This course focusses on the protective relaying principles, settings and operation during fault condition in power system.

Course Outline: The course will discuss the role of main, back up and redundant relay protection scheme and identification of zones of protection for a given substation. The selection of proper instrument transformer inputs to the relaying schemes and analysis and calculation of currents in a system for various types of fault will be demonstrated. Introduction to the concept of both high impedance and low impedance protection relays to protect power system buses. In addition, protection of rotating machines and distribution networks will also be covered in the syllabus.

Course Modules with Quantitative lecture hours:

Introduction – 3 hours
Fundamentals of protection – Security, selectivity and reliability, measurement principles – unit and non-unit protection, legacy relays, solid state and numerical relays, standards in power system protection

Instrument Transformers – 4 hours
Working principle of current transformers (CT), voltage transformers (VT), dynamic response of CTs and capacitor coupled voltage transformer (CCVT) during faults and its effect on relaying

Fault Analysis using Symmetrical components – 4 hours
Sequence components, sequence modelling of power system components such as transformers, generators, transmission lines, fault analysis

Numerical Relaying – 4 hours
Sampling of analog values, analog to digital conversion, least square method for estimation of phasors, Fourier analysis, discrete Fourier transform: properties, phasor calculation, fast Fourier transform.

Directional Overcurrent Protection – 4 hours
Directional and overcurrent relay principles, directional relay coordination problem associated with multiple loop system.

Transmission line Protection – 6 hours
Distance and non-distance-based protection concepts. Zones of protection and back up protection, distance relay settings, pilot protection with distance relays

Power Swing – 2 hours
Power swing detection, stable and unstable swing, blocking and unblocking of distance relays during power swing, analysis of power swing in multi machine system, operation of relays during out of step condition.

Transformer protection – 3 hours
Inrush phenomenon, Inrush detection methods; Differential and over-excitation protection.

Bus Protection – 3 hours
Bus configurations; High and low impedance protection concepts. External Fault detection methods and remedial measures to account for CT saturation detection.

Rotating Machinery Protection – 4 hours
Motor and generator protection, generator construction and grounding methods, Detection of faults and abnormal operating conditions

Distribution system protection – 2 hours
Feeder protection philosophies, Coordination examples, Power system restoration concepts – Reclosing, Automatic sectionalizing.

Introduction to relay setups and Standards– 3 hours
Distance, overcurrent, over/under frequency relay set up demonstration. Discussion on standards for protection scheme in Indian power grid.

Text book:
1. S. Horowitz and A. G. Phadke, *Power System Relaying (4th ed.)*. Wiley, 2014.
2. A. G. Phadke and J. S. Thorpe, *Computer Relaying for Power Systems*, Wiley, 2009
3. Juan Gers, *Protection of Electricity Distribution Networks (3rd ed.)*, IET press, 2011.

References:
1. P. M. Anderson, *Power System Protection*, Wiley-IEEE press, 1999.
2. J. L. Blackburn, T. J. Domin, *Protection Relaying: Principles and Applications (3rd ed.)*, Taylor and Francis, 2006
3. J. D. Glover, M. S. Saema, T. J. Overbye. *Power System Analysis and Design (5th ed.)*, Cengage Learning, 2010.
4. Bhavesh Bhalja, R. P. Maheshwari and N. Chothani, *Protection and Switchgear*. Oxford University Press, 2nd Edition, New Delhi, India, 2019.

Similarity Content Declaration with Existing Courses:

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	EE303	Sequence components, sequence modelling of power system components such as transformers, generators, transmission lines	7

Proposed by: **Pratim Kundu**   School of Computing and Electrical Engineering

IIT Mandi

Proposal for a New Course

Course Number: EE630
Course Name: HVDC Transmission and Flexible AC Transmission Systems
Credits: 3-0-0-3
Prerequisites: EE-303 (Power systems) and EE-309 (Power electronics)
Intended for: PG
Distribution: Elective for M.S., M. Tech. & Ph.D.

Preamble: The deregulation of the electricity market together with increasing constraints resulting from social opposition to the installation of new facilities brings great pressure to the operators of transmission and distribution systems. Large scale integration of renewable energy into power supply brings further pressure on how to operate and control future power networks. These new trends require the need for flexibility, power quality and increased availability of electricity transmission and distribution systems by using new devices which can be implemented with limited investments, short delivery times and short planning and decision-making horizons. FACTS (Flexible AC Transmission Systems) is a terminology to describe a whole family of concepts and devices for improved use and flexibility of electrical power systems. HVDC is used for long distance power delivery, interconnection of asynchronous AC systems and integration of large-scale renewable energy systems.

Course Outline: The course covers the basic concepts and operating principles for integration of HVDC system and FACTS devices to the existing power network. The students will be introduced to the evolution of HVDC systems, and comparison of HVAC and HVDC transmission systems. The components involved in HVDC transmission system, analysis of HVDC converters, and HVDC control will be taught. The course will also focus on FACTS devices and their use to improve the operation of power networks. Application of HVDC system and FACTS devices to existing power system in relation to integration of renewable energy will be covered. Also, the new developments in multi-terminal HVDC Grid will be discussed.

Course Modules with Quantitative lecture hours:

Introduction to HVDC – 5 hours
Introduction of DC power transmission technology, comparison of AC and DC transmission, limitation of HVDC transmission, reliability of HVDC systems, application of DC transmission, description of DC transmission system, planning for HVDC transmission, modern trends in DC transmission, advantages of HVDC.

Analysis of HVDC converters – 4 hours
Simple rectifier circuits, required features of rectification circuits for HVDC transmission, choice of converter configuration, converter bridge characteristics

Control of HVDC converter and systems: – 5 hours
Necessity of control of a DC link, rectifier control, compounding of rectifiers, power reversal of DC link, voltage dependent current order limit (VDCOL) characteristics of the

converter, inverter extinction angle control, pulse phase control, starting and stopping of DC link, constant power control, control scheme of HVDC converters.

Harmonics and filters: – 5 hours
Generation of harmonics by converters, characteristics of harmonics on DC side, characteristics of current harmonics, characteristic variation of harmonic currents with variation of firing angle and overlap angle, effect of control mode on harmonics, non-characteristic harmonic.

FACTS devices: – 5 hours
Introduction to FACTS; Compensation of transmission systems, Series and Shunt FACTS controllers - variable impedance type and switched converter type, Unified Power Flow Controller and other types of FACTS devices.

Load flow and stability analysis: – 5 hours
Component Models for the Analysis of AC DC Systems, Power flow analysis of AC-DC systems, Transient stability analysis, Dynamic stability analysis. Application of FACTS controllers in improvement of power system operation and stability.

Reactive power control: – 3 hours
Reactive power requirements in steady state, sources of reactive power, static VAR systems, reactive power control during transients

Fault and protection schemes in HVDC systems: – 5 hours
Nature and types of faults, faults on AC side of the converter stations, converter faults, fault on DC side of the systems, protection against over currents and over voltages, protection of filter units.

Multiterminal HVDC systems: – 5 hours
Types of multiterminal (MTDC) systems, parallel operation aspect of MTDC. Control of power in MTDC. Power upgrading and conversion of AC lines into DC lines, Parallel AC/DC systems, FACTS and HVDC system application in wind power generation- VSC based applications for wind power systems

Text book:
1. K. R. Padiyar, *HVDC Power Transmission Systems*. Wiley, 1990
2. J. Arrillaga, *High Voltage Direct Current Transmission*. The Institution of Electrical Engineers, London, UK, 1998.
3. N. G. Hingorani, *Understanding FACTS*, IEEE Press, 2001.

References:
1. K. R. Padiyar, *FACTS Controllers in Power Transmission and Distribution*. New age international (p) limited, 2007.
2. EW Kimbark, *Direct Current Transmission*. Wiley-Interscience. New York, 1971.
3. S N Singh, *Electric Power Generation, Transmission and Distribution*. PHI, New Delhi 2nd edition, 2008.
4. T J E Miller, *Reactive Power Control in Electric Systems*, Wiley, 1982

Similarity Content Declaration with Existing Courses:
NA

Proposed by: **Pratim Kundu**   School of Computing and Electrical Engineering

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Name	: Engineering of Instrumentation
Course Number	: EP401P
Credits	: 1-0-5-4
Prerequisites	: PH301 or PH513 and PH501 or PH523.
Intended for	: B.Tech. in Engineering Physics
Distribution	: Core course for B.Tech. in Engineering Physics.

Preamble: This course is aimed at giving instrumentation exposure to students by lectures on various techniques along with demonstration and hands on practices for small scale instruments with central focus on the working physics.

Modules:

1. Introduction to data Acquisition systems, Labview/open source (such as Python) programming (Interfacing and programming), Signal processing and Error analysis.
2. Automatic control (PID control, Feed forward control, Time delay and inverse response systems, Sequence control).
3. Cryogenics Instrumentation (Low temperature, Liquefaction of gases, Close Cycle Refrigerator, Temperature sensor). Vacuum pumps (Rotary, Dry scroll, Root pumps) with focus on role of valves, gauges etc.
4. Introduction to design and working of instruments (Electron microscope, Scanning Tunneling Microscopy, Atomic force microscope and Superconducting magnets)

Textbooks:

1. Transmission Electron Microscopy, by C. Barry Carter and David B. Williams, Springer, New York (2016).
2. Experimental Techniques in Condensed Matter Physics at Low Temperatures, by Robert C. Richardson and N. Smith ; CRC Press (2018).

References: *As advised by the course instructors.*

1. **Similarity Content Declaration with Existing Courses**

S.N.	Course Code	Similarity Content	Approx. % of Content
1			

2. **Justification for new course proposal if cumulative similarity content is > 30%:**
NA.

Proposed by: Course Interest Group   School: _____

Signature: _____   Date: _____

Recommended/Not Recommended, with Comments:

--   Date: _____

Chairman, CPC

Approved/Not Approved

--   Date: _____

Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Name : Eng. Physics Practicum
Course Number : EP402P
Credits : 1-0-5-4
Prerequisites : PH301 or PH513 and PH501 or PH523.
Intended for : B.Tech. in Engineering Physics
Distribution : Core course for B.Tech. in Engineering Physics.

Preamble: This experimental course is expected to develop the art of experimentation and analysis skill, collaborative learning skills among students along with the hands-on training in making the devices.

Course Outline: The course content includes basic physics experiments from various modules of physics, the theory of which students have learnt during their core courses and basic training in device making.

Part A

1. Hall Effect in Semiconductor
Measure the resistivity and Hall voltage of a semiconductor sample as a function of temperature and magnetic field. The band gap, the specific conductivity, the type of charge carrier and the mobility of the charge carriers can be determined from the measurements.

2. Diffraction of ultrasonic waves
Fraunhofer and Fresnel diffraction and determine the wavelength of the ultrasound wave. Students may also develop their own sound wave generator and receiver and perform this experiment.

3. Geiger-Müller-Counter
To study random events. Determination of the half-life and radioactive equilibrium. Verification of the inverse-square law for beta and gamma radiation.

4. Dispersion and resolving power of a grating
Determination of the grating constant of a Rowland grating based on the diffraction angle (up to the third order) of the high intensity spectral lines. Determination of the angular dispersion and resolving power of a grating. Students may also design their own gratings and study that using this experimental technique.

Devices Fabrication Technologies

- **Basic clean room training and introduction to instruments**
  Draw a comprehensive wafer clean process flow/cleaning of wafer and validate the hydrophobic and hydrophilic nature through contact angle measurements.
- **Metal-Semiconductor contact fabrications and characterizations**

Proposal for a New Course

Design and fabricate basic metal semiconductor junction and do the characterization. Basic characterization may also be extended to thin films grown via spin coater or any other technique.

Textbooks:
1. R. A. Dunlop, Experimental Physics, Oxford University Press (2012).
2. S. K. Ghandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, 2nd Edition. (2014)

References:

1. A. C. Melissinos, Experiments in Modern Physics, Academic Press (1996).
2. E. Hecht, Optics, Addison-Wesley; 4 edition (2011)
3. J. Varma, Nuclear Physics Experiments, New Age Publishers (2010)
4. B. L. Worsnop and H. T. Flint, Advanced Practical Physics for Students, Methusen& Go. (1950).
5. E. V. Smith, Manual for Experiments in Applied Physics. Butterworths (1970).
6. D. Malacara (ed), Methods of Experimental Physics, Series of Volumes, Academic Press Inc. (1988).
7. D. K. Schroder, Semiconductor Material and Device Characterization, 3rd Edition.

1. **Similarity Content Declaration with Existing Courses**

S.N.	Course Code	Similarity Content	Approx. % of Content
1	PH515P	Part of section A	20%

2. **Justification for new course proposal if cumulative similarity content is > 30%:** NA.

Proposed by: Course Interest Group   **School:**

Signature: _____   **Date:** _____

04 Jun. 21

Recommended/Not Recommended, with Comments:

---   **Date:** _____

Chairman, CPC

Approved/Not Approved

---   **Date:** _____

Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Name: Quantum Field Theory

Course Number: PH 606

Credits: (3-0-0-3)

Prerequisites: Quantum Mechanics (PH513), Mathematical Physics (PH511).

Intended for: M.Sc. (Physics), Ph.D., I-Ph.D., B.Tech 3rd and 4th Year.

Distribution: Elective for I-Ph.D., Ph.D., M.Sc., B.Tech 3rd and 4th Year.

Preamble: Quantum field theory forms one of the central pillars of modern theoretical physics. The objective of the proposed course is to introduce students to some key ideas and methods in quantum field theory and also discuss relevant applications.

Course Outline: The course will start with a review of second quantization and some mathematical tools such as functional analysis. Then the course will move on to more formal and rigorous treatment of quantum fields. Important ideas of quantization of fields, symmetries, Feynman diagrams, and propagators will be introduced with several examples in the first five modules (canonical quantisation formulation). The instructor can choose either of the Module 6 (each of which is aimed at specific applications).

Modules:

Module 1: Mathematical preliminaries, Lagrangian and Hamiltonian density, second quantization, functionals, path integrals, functional field integrals, coherent states for bosons and fermions. [7 hours]

Module 2: Classical fields, Klein-Gordon field, massless scalar field theory, massive scalar fields, Phi-4 theory, complex scalar fields. [5 hours]

Module 3: Schrodinger, Heisenberg, and interaction pictures, time-evolution operator, translations and rotations in space-time, transformations of quantum fields, symmetries and conservation laws, Noether's theorem. [8 hours]

Module 4: Canonical quantization of fields with examples, normal ordering, internal symmetries, massive vector fields, polarizations, gauge fields and gauge theory. [7 hours]

Module 5: Propagators and Green's functions, Dyson equation, field and Feynman propagator, Smatrix, perturbation expansion, Wick's theorem, Feynman diagrams. [7 hours]

Module 6 (some applications of field theory in condensed matter physics): Superfluids and fields, Fermi liquid theory, field theory formulation of many-body problem in metals and superconductors, Hartree-Fock energy, random phase approximation, fractional quantum Hall effect. [8 hours]

OR

Module 6 (some applications of field theory in particle physics): Dirac and Weyl equation, spinors, transformation of spinors, quantizing the Dirac field, fermion propagator, quantum electrodynamics (QED), Feynman rules, QED scattering cross sections.   [8 hours]

Books:

Text

1. Quantum field theory for gifted amateur, by Lancaster and Blundell, Oxford (2014).
2. Quantum field theory, by Mandl and Shaw, John Wiley and Sons (2010).
3. An introduction to quantum field theory, by Peskin and Schroeder, CRC Press (2018).

References

1. Quantum theory of Fields, Vol.1, by S. Weinberg, Cambridge (1995).
2. Quantum field theory, by M. Srednicki, Cambridge (2007).
3. Quantum field theory by M. H. Ryder, Cambridge (1996).

Online resources:

1. David Tong: lectures on QFT http://www.damtp.cam.ac.uk/user/tong/qft.html
2. Lectures on advanced quantum mechanics by Freeman Dyson. https://arxiv.org/pdf/quant-ph/0608140.pdf

Similarity Content Declaration with Existing Courses:

Sl. No.	Course code	Similarity content	Percentage
1)	PH 512 Classical Mechanics	Lagrangian, least action.	< 5%
2)	PH 613 Special topics in Quantum Mechanics	Klein-Gordon and Dirac equation.	< 5%
3)	PH 521 Electromagnetic Theory	Electromagnetic field tensor.	< 5%
4)	PH 613 Special topics in QM.	Klein-Gordon and Dirac equation	<5%

Justification for new course proposal if cumulative similarity content is > 30%: N/A
Approvals:
Other Faculty interested in teaching this course:
Proposed by: Dr. Girish Sharma (SBS)
        and Dr. Sudhir Pandey (SE). 10 (/01/2021) **School:** School of Basic Sciences (SBS)
Signature: Girish Sharma   Date:

Recommended/Not Recommended, with Comments:

                                                          Date:

Chairman, CPC
Approved / Not Approved

                                                          Date:

Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number: BE 301
Course Name:Biomechanics
Credits: 3-0-2-4
Prerequisites: Mechanics of Rigid Bodies (IC 240)
Intended for: B. Tech M.Tech Integrated Dual Degree Bioengineering students
Distribution: Core for Integrated Dual Degree Bioengineering students

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1. Preamble:

The course provides an overview of musculoskeletal anatomy, plant mechanics, the mechanical properties and structural behavior of biological tissues, and bio-dynamics. Specific course topics will include structural and functional relationships in tissues and organs; application of stress and strain analysis to biological tissues; analysis of forces in human function and movement; energy and power in human activity; introduction to modeling viscoelasticity of tissues.

2. Course modules with Quantitative lecture hours:

Theory: [42 hours]

Module I: Introduction and Fundamentals: What is Biomechanics? Anatomical Concepts in Biomechanics, free-body diagrams and equilibrium; linear and angular kinematics, kinetic equation of motion, work and energy method, application to biological systems: stress, strain, Modulus, strain energy, tension, compression, torsion, bending, buckling.   [14 hours]

Module II: Tissues: Animal tissues and plant tissues. Classification of animal tissues - hard tissue, soft tissue, properties of plant and animal tissues according to mechanics view point, Structure, Function, composition, material properties and modeling of tissues, Plant tissues – vascular bundles – xylem and phloem. Continuum Mechanics Concepts in Modeling of large deformation, Finite Element Modeling. [14 hours]

Module III: Joints and Movements: Classification of joints, forces and stresses, biomechanical analysis joints, Gait, Joint replacement and reasons, Finite Element Modeling.   [8 Hours]

Module IV: Biofluid mechanics: Flow properties of blood and others, Fluid flow in plants, Dynamics of fluid flow in the biological system - modeling and experimental approaches, Measurement/Estimation of In-vivo elasticity of fluid transporting vessels.   [6 Hours]

Lab: [28 hours]
1. To determine the tensile properties of a material (root or bones or plants or others).
2. To determine the bending properties of a material (root or bones or plants or others).
3. To determine the hardness properties of a material.

Proposal for a New Course

4. To determine the torsional/shear properties of a material (root or bones or plants or others).

5. To determine the buckling properties of amaterial (root or bones or plants or others).

6. To determine the energy absorbed and toughness of amaterial (root or bones or plants or others).

7. To determine the wear properties of material and different combination of material

8. To determine the ground reaction force during normal walking or running.

9. Finite ElementModelling and analysis of hard tissue and soft tissue (examples: Bone, ligaments or muscles)

10. Fluid flow through the cardiovascular system: Simple modelling and analysis

3. **Text Books:**

(a) Basic Biomechanics of the Musculoskeletal System. M. Nordin&V. H. Frankel, Publisher- Lippincott Williams and Wilkins, 2012.

(b) Biomechanics: Mechanical Properties of Living Tissues. Y. C. Fung, Springer, Second edition, 2007.

4. **Reference Book:**

(a) Plant Biomechanics: An engineering approach to plant form and function, K. J. Niklas, University of Chicago Press, 1992.

(b) Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, Ozkaya,Nordin, Goldsheyder and Leger. Third edition, Springer, 2014.

(c) Fundamentals of Biomechanics, R. L.Huston, CRC Press, 2013

5. **Similarity content declaration with existing courses:**

Sl. No.	Course Code	Similarity Content	Approx. % of content
Mechanics of Solids	ME 206	Stress, strain, Modulus, strain energy, tension, compression, torsion, bending, buckling	15 %

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

Approvals: Other faculty interested in teaching this course:

Proposed by: Dr. Rajesh Ghosh
School: SE

Signature: *R. Ghosh*   Date: 10/02/2021

Recommended/Not Recommended, with comments:

Chairman, CPC   Date:

Approved/Not approved

Chairman, Senate   Date:

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number: BE303
Course Name: Applied Biostatistics
Credits: 3-0-2-4
Prerequisites: IC252, IC272
Intended for: B. Tech M.Tech Integrated Dual Degree Bioengineering students
Distribution: Core for Integrated Dual Degree Bioengineering students, elective for other B.Tech students
Semester: 4th semester

Preamble: Probability theory and statistical analysis are fundamental concepts in medical and biological sciences due to the random processes involved. To form new knowledge and to test hypotheses in these sciences, this random nature renders experiments imperative, which are based on a set of trials which form a composed experiment. The desired function of novel medical and biological techniques and instruments can only be verified by experimental analysis in combination with statistical tools to evaluate the proper functioning. The foundations laid in this course provide the necessary vocabulary and facilitates the understanding of fundamental core concepts in medical and biological statistical analysis and experimentation.

Objectives: This course is intended to cover fundamental concepts in biostatistics, data science in biology, and how to apply these concepts using the R statistical programming language. In general, this course will emphasize applied statistical theory on biological data analysis. The student should be able to understand fundamental terms (e.g., incidence, prevalence), and to evaluate different types of medical studies and data collection, for example to be aware of importance of sample size determination. Important aspects of medical tests (e.g., sensitivity and specificity) and its impact on device development will be understood by the student. After the course the student can apply concepts of various statistical tests and understands concepts of multivariate analysis. Students are aware of problems and fallacies of statistical analysis.

Module 1- Study design, data acquisition, and presentation:

Recognize and give examples of different types of data arising in public health and clinical studies. Types of medical studies and introduction of different study designs (descriptive vs analytical, control groups etc.) and sampling methods (randomization). Risk studies (descriptive, case-control and cohort studies) Measure of important probabilities (incidence, prevalence, sensitivity-specificity-predictivity, morbidity, etc.). Example of study design at the example of a clinical trial for approval process.   (10 hours)

Module 2- Null hypothesis, Statistical testing:

Why are there statistical tests in medial and biological sciences? Formulation and examples of null hypothesis for medical and bioengineering applications, subsequent decisions, and error types I + II.
Overview of tests: location (e.g., t-test), dispersion (e.g., ANOVA (f-test)), comparison of frequencies (chi-square), variance analysis (e.g., inter- and intra-class variance) and regression analysis (linear and logistic regression (ROC-analysis)). *Parametric tests* are used

only where a normal distribution is assumed. These are the t-test (paired or unpaired), ANOVA (one-way non-repeated, repeated; two-way, three-way), linear regression and Pearson correlation.

Non-parametric tests are used when continuous data are not normally distributed or when dealing with discrete variables. These are chi-squared, Fisher's exact tests, Wilcoxon's matched pairs, Mann–Whitney U-tests, Kruskal–Wallis tests and Spearman rank correlation. Comparison of different tests. Analyze required sample size (calculate the power of a test) and analysis of correct application of a test using specific examples.   (15 hours)

Module 3: Advanced tools – Introduction to multivariate analysis

Multivariate analysis is concerned with the interrelationships among several variables. A specific example for the motivation of multivariate analysis will be given. The course includes the following methods: cluster analysis, principal components analysis, factor analysis, discriminant analysis, etc. Designs of Experiments which will include, one-way, two-way ANOVA, MANOVA study design, confounding and standardization. Difference between multiple linear regression and multivariate regression (e.g., using an example of the Framingham heart study)   (7 hours)

Module 4: Applications of biostatistics, quality, and potential fallacies

Introduction to survival analysis, estimation of survival curves, and proportional hazards model (e.g., example of life expectancy under different conditions). Analysis of different parametric survival functions.

Quality considerations: Quality of statistical models and quality of data. Dealing with erroneous data, missing values, bias of observer etc.

Demonstration of statistical fallacies due to data (biased sample, inadequate sample size, incomparable objects), erroneous analysis (linear analysis of nonlinearities, biased data selection, misuse of p-values, etc.) and errors or misuse of presentations (misuse of percentages or wrong base for percentages, misuse of means etc. Misuse of graphical representation.   (10 hours)

Lab: Tentative list of experiments:

1. Introduction to R using RStudio
2. Analysis of data used in public health with real life examples
3. T-test with biological data set
4. ANOVA test with biological data set
5. Application of Wilcoxon's Signed Rank test
6. Application of Mann Whitney U test
7. Kruskal-Wallis-test
8. Meta-analysis of the disease data
9. Equivalence study
10. Cross sectional study
11. Regression analysis
12. Multivariate Methods
13. Categorical data analysis

Textbook:

1. Abhaya Indrayan and Rajeev Kumar Malhotra, Medical biostatistics, Chapman and Hall, 2017.

Reference book:

1. Fundamentals of Biostatistics, 8th Edition. Bernard Rosner. Cengage Learning Inc., 2015
2. Biostatistics and Epidemiology: A Primer for Health and Biomedical Professionals, Wassertheil-Smoler, Springer-Verlag 2014.
3. Design and Analysis of Clinical Trials: Concepts and Methodologies, Shein-Chung Chow, Jen-Pei Liu, 3rd edition, Wiley, 2016.

1. **Similarity content declaration with existing courses:**

Sl. No.	Course Code	Similarity Content	Approx. % of content
1	IC252	Null hypothesis, type I+II error	7 %
2	IC272	Regression analysis	5 %
3	HS550	Regression analysis, ANOVA	50% - 60%

2. **Justification of new course proposal if cumulative similarity content is >30%:**
HS550 and BE303 are mutually exclusive.

Approvals:
Proposed by: Dr. Sarita Azad
School: SBS

Other faculty interested in teaching this course: Dr. Erwin Fuhrer

Signature: _Sarita Azad_   Date:

Recommended/Not Recommended, with comments:

Chairman, CPC   Date:

Approved/Not approved

Chairman, Senate   Date

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Name: Bioinformatics

Course Number: BE304

Credit: 2-0-2-3

Prerequisites: Understanding Biotechnology and its applications (IC136)

Intended for: B. Tech M.Tech Integrated Dual Degree Bioengineering students
Distribution: Core for Integrated Dual Degree Bioengineering students, elective for other B.Tech students
Semester:

Course Outline:
Objective: The course is aimed at providing a basic understanding to the students about bioinformatics methods and their in-depth applications for solving biological problems. The course will include practical sessions for the students to help them master some of the bioinformatics techniques from hands-on experience. The course may also involve a project/term-paper development towards important biological problems within the purview of the course.
Introduction to Bioinformatics: What is Bioinformatics? What are the applications of Bioinformatics? (1 hour)
Introduction to Basic Programming: Introduction to basic scripting and programming routinely used for bioinformatics analysis. (10 hour)
Sequence and Molecular File formats: Introduction to different file formats used for biological data. Sequence and molecular file conversion tools. (1 hour)
Databases in Bioinformatics: Introduction to different biological databases, their classification schemes, and biological database retrieval systems. (2 hour)
Sequence Alignments: Introduction to concept of alignment, Scoring matrices, Alignment algorithms for pairs of sequences including Dot Matrix plot, Dynamic programming and Heuristic algorithms such as BLAST, Multiple sequence alignment (Clustal), Global and local alignment algorithms. (12 hour)
Motif Identification: Introduction to motif identification in DNA and proteins including consensus and probabilistic approaches. (2 hour)

Lab Course content:
1. Perl programming (3 labs)
2. Databases for Bioinformatics and format conversion. (2 labs)
3. Sequence similarity (Local alignment, including BLAST) (2 labs).
4. Sequence similarity (Global alignment, Clustal) (2 labs).
5. Motif Identification (1 lab)

Text Book:
1. Bioinformatics: Methods and Applications Genomics, Proteomics, and Drug Discovery S.C. Rastogi, N. Mendiratta, P. Rastogi (3rd Edition) PHI Learning Private Limited New Delhi (2011)

Proposal for a New Course

2. Bioinformatics Principles and Applications. Z. Ghosh and B. Mallick Oxford University Press. (2015), ISBN 10: 0195692306; ISBN 13: 9780195692303.

Other References:
1. Introduction to Bioinformatics. Arthur M. Lesk (3rd Edition) Oxford University Press.
2. Biological Sequence Analysis-Probabilistic Models of Proteins and Nucleic Acids, by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison. Cambridge University Press.
3. An Introduction to Bioinformatics Algorithms, by Neil C. Jones and Pavel A. Pevzner, MIT Press.

Articles:
Latest research articles will be advised related to the topic being taught.

Similarity content declaration with existing courses: None

Sl. No.	Course Code	Similarity Content	Approx. % of content
01.	BY512	Sequence similarity methods basics, Perl programing, Databases	20%

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

Approvals:
Other faculty interested in teaching this course: Dr. Shyam K Masakapalli

Proposed by: Dr. Tulika P Srivastava   School: SBS

Signature: Date: 20th January, 2021

Recommended/Not Recommended, with comments:

Chairman, CPC   Date:

Approved/Not approved

Chairman, Senate   Date:

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number	: CE561
Course Name	: The science of climate change
Credits	: 3-0-0-3
Prerequisites	: IC 230 (Environmental Science) or equivalent
Intended for	: 3rd and 4th year B.Tech., PG
Distribution	: Elective

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(1) Preamble:

While we are generally familiar with the projections of human-induced global warming and its catastrophic consequences for the world, it is desirable that we are equally aware of the basic scientific principles that define and mould this phenomenon. This is especially important given the requirement for sustainable infrastructure and societies to be necessarily climate-resilient, and therefore, the need for practitioners of science, technology and policy to be climate-conscious. This course aims to present to students the most current scientific understanding of global warming and associated climate change, charting a course from natural climatic fluctuations on geological timescales to the modern-day climate and its forcing by anthropogenic activities. It also aims to prepare students to participate in environmental decision-making by providing scientific, technological and policy perspectives on climate change.

1. Course Modules:

Module 1: Earth system concepts and early climate   [5 Hours]
State of a system and couplings; negative and positive feedback loops; system response to feedbacks; stable and unstable equilibrium states; application of these concepts to the Daisyworld climate system; formation and composition of the early atmosphere, and the effect of early life; the Great Oxidation Event and the ozone shield; early climate and its evolution over time

Module 2: Basics of global climate   [7 Hours]
Components of the climate system, timescales and the parameterization problem; basics of energy balance and radiative forcing; atmospheric and oceanic circulation and their role in energy redistribution; conservation of momentum, equations of state, temperature and continuity equations, moist processes, wave processes; natural climate variability – El Nino Southern Oscillation (ENSO) dynamics, ENSO teleconnection and prediction

Module 3: Long-term climate regulation and proxies   [6 Hours]
The Faint Young Sun paradox – a CO_2 and CH_4-rich early atmosphere; geological indicators of paleoclimate; isotopic proxies and temperature reconstruction; long-term glacial record and evidence of past glaciations; low-latitude glaciation and the Snowball Earth; banded-iron formations and cap carbonates; Pleistocene glaciations and the Milankovitch Cycles; climate record from the Dome C and Vostok ice cores – evidence of anthropogenic influence

Module 4: The greenhouse effect and climate feedbacks [5 Hours]

Global energy balance model with a 1-layer atmosphere – IR emissions and temperature; magnitude of the greenhouse effect; global warming potential; climate feedbacks and climate sensitivity – water vapour, snow/ice, cloud, lapse rate and stratospheric cooling feedbacks; climate response time and sensitivity in transient climate change – doubling of CO_2, ocean warming

Module 5: Modern climate and human influence [7 Hours]

Climate change during the Holocene and the industrial era; the carbon, nitrogen and water cycles and their perturbations, carbon emission intensity, estimating emissions from the Kaya Identity, CO_2-equivalents; radiative forcing of other greenhouse gases (CH_4, N_2O, halocarbons) and aerosols since industrialization

Module 6: Effects of climate change in the polar regions and the Himalayas [5 Hours]

Effects of climate change on the cryosphere; temperature and precipitation trends in the poles and the Himalayas under a changing climate; aerosol deposition, snow cover change and glacier melting; effects on stream flow and water resources; the National Action Plan on Climate Change and the National Mission for Sustaining the Himalayan Ecosystem; resilience and adaptation of Himalayan communities to climate change

Module 7: Climate projections for the future and adaptation/mitigation strategies [7 Hours]

Emission paths and scenarios; globally-averaged response to warming scenarios; coupled climate models, projections and multi-model ensemble averages; mitigation strategies – climate-smart agriculture, energy efficiency, GHG accounting, renewable energy, sustainable urban systems

2. **Textbooks:**
   i) Climate Change and Climate Modeling; 4th Edition, 2015; J. David Neelin; Cambridge University Press.
   ii) The Earth System; 3rd Edition, 2010; Lee R. Kump, James F. Kasting, Robert G. Crane; Prentice Hall.

3. **References:**

   i) Earth System Science in the Anthropocene; 1st Edition, 2005; Eckhart Ehlers, Thomas Krafft; Springer.
   ii) Chemistry of the Upper and Lower Atmosphere; 2nd Edition, 2000; Barbara J. Finlayson-Pitts and James N. Pitts Jr; Academic Press.
   iii) Atmosphere, Ocean and Climate Dynamics; 1st Edition, 2007; John Marshall and R. Alan Plumb; Academic Press.
   iv) Relevant IPCC reports: AR5 Climate Change 2013 – The Physical Science Basis; Global Warming of 1.5°C; The Ocean and Cryosphere in a Changing Climate.
   v) Research articles will be advised as required.

Proposal for a New Course

4. Similarity Content Declaration with Existing Courses

S.N.	Course Code	Similarity Content	Approx. % of Content
1	CE558 Air Pollution and its Mitigation	Global energy balance and greenhouse effect	5%

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

Approvals:

Other Faculty interested in teaching this course:

Proposed by: Dr. Sayantan Sarkar   **School:** School of Engineering

Signature: **Date: 25/1/2021**

Recommended/Not Recommended, with Comments:

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Chairman, CPC

Approved/Not Approved

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Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Name: Advanced Topics in Deep Learning
Course Number: CS672
Credits: 3-0-2-4
Prerequisites: CS671: Deep Learning and its Applications.
Distribution: Discipline Elective for final year BTech CSE, DSE and EE, Elective for other final year B.Tech disciplines, MS, M.Tech, and Ph.D. students.

Preamble: In the recent world deep learning has taken the center stage to solve most of the real-world problems that can be framed as an AI/ML problem. It has been observed that deep learning has started from scaling and tweaking existing algorithms. But now deep learning-based optimization frameworks are now exploring new horizons of machine learning to solve real-world problems with human-level precision. In this course, our focus will be to unravel some of these new learning paradigms and explore their feasibility and scope.

Course Outline: This course will start by exploring some recent generative and adversary network (GAN) architectures utilized for generating new media by learning the data distribution directly. Later a whole new series of Transformer networks will be covered followed by the latest deep learning paradigm of Deep Reinforcement Learning. The graph-based neural networks will be studied in order to understand learning over irregular data. Finally, several recently proposed deep learning paradigms such as capsule nets of teacher-student networks will be covered.

Course Content :

1. **GAN series** (8 Hrs): Deep Convolutional GAN (DCGAN), Conditional GAN (cGAN), Wasserstein GAN (WGAN), Stacked GAN (StackGAN), Attention GAN, Picture to Picture GAN (Pix2Pix), Cyclic GAN (Cycle GAN), Discover Cross-Domain Relations (DiscoGAN), Super Resolution GAN (SRGAN), Texture GAN, Self Attention GAN (SAGAN)

2. **Transformer Networks** (6 Hrs): Drawbacks of Recurrent Neural Networks, Self Attention, Transformers, Bidirectional Encoder Representation from Transformer (BERT), Generative pre-trained Transformer (GPT).

3. **Deep Reinforcement Learning** (10 Hrs): Basic of reinforcement learning, Markov decision process, Value and Q-value functions, Deep Q-learning, Deep Policy Gradient iteration (Reinforce Algo)

4. **Graph-based Deep Learning** (5 Hrs): Basics of Graph Convolutional Neural Network (GCN), Graph Embeddings, Spectral and Spatial GCNs, Graph Autoencoders.

5. **Some latest miscellaneous deep learning paradigms and concepts** (10 Hrs):
    a. Capsule Network
    b. Teacher-student network
    c. Attention and Self-attention mechanism

d. Multi-task learning

e. Novel loss functions

f. Model compression/Network Pruning: redundant filter removal, filter ranking, and filter attention.

g. Explainable AI

6. **Advance deep learning application** (3 hrs) **(optional/cover in above topics/related to projects):**

a. CV related: Object detection, Tracking with Re-id, Flow networks,

b. NLP related: Summarization, text generation,

c. Misc: Domain Adaptation etc.

Reference Material:

- **[Lecture Material]** Most of the material will be covered from the recently published research papers at prestigious venues like NIPS, CVPR, ECCV, ICCV, ICLR, etc.

- **[Textbook]** Dive into Deep Learning by Aston Zhang et.al.
  (Book website: https://d2l.ai/) (Book PDF: https://d2l.ai/d2l-en.pdf)

- **[Reference Books]** Deep Learning by Ian Goodfellow and Yoshua Bengio and Aaron Courville (Book website: https://www.deeplearningbook.org/)

- **[Few Reference Courses]**
  o [CS231n, DL Stanford course] https://www.youtube.com/watch?v=vT1JzLTH4G4&list=PLC1qU-LWwrF64f4QKQT-Vg5Wr4qEE1Zxk

  o [CS224n, NLP Stanford course] https://www.youtube.com/watch?v=8rXD5-xhemo&list=PLoROMvodv4rOhcuXMZkNm7j3fVwBBY42z

  o [DeepMind RL course by David Silver] https://www.youtube.com/watch?v=2pWv7GOvuf0&list=PLqYmG7hTraZDM-OYHWgPebj2MfCFzFObQ

1. Similarity Content: Less than 5%. Only some overlap in the first topic of Modules 1 and Module 2 with "CS671: Deep learning and its Applications".

Approvals:

Other faculty interested in teaching this course: Dr. Arnav Bhavsar and Dr. Dileep A.D, SCEE

Proposed by: Aditya Nigam   School: SCEE

Signature_____   Date_____

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course number	: EE551
Course Name	: Applied Photonics for Scientists and Engineers
Credit	: 2-1-0-3
Prerequisite	: IC110, IC111, IC221
Intended for	: UG, PG, M. Tech, M. Sc. Physics, I-PhD, PhD

1. Preamble:

Photonics is a powerful enabling technology that offers unique tools and solutions for innovation. But beyond this, photonics can be also viewed as a gateway discipline – as it can be used to bridge the gap between disciplines towards making valuable long-standing contributions.

This course aims to equip the students with the conceptual foundations of the principles of photonics, and requisite skills for enabling them to apply it in their own disciplines. The course topics will include essential principles of photonics, but with a focus on their applications. It is expected that at the end of the module, students will be able use core principles and applied techniques of photonics in their respective disciplines.

Pre-requisites for this course are a working knowledge of calculus, vector and matrix algebra. A basic understanding of vector calculus and Fourier transforms are desirable, though not necessary.

Upon completion of this module, it is expected that students will be able to

- *describe* light propagation and its interaction with diverse media using wave and ray models.
- *use* basic photonic components and devices in their own disciplinary areas.
- *analyze and evaluate* the use of photonic-based technologies in real-world interdisciplinary applications.

2. Course Modules with quantitative lecture hours:

Fundamentals of the Electromagnetic theory of light – complex representation of electromagnetic field disturbances, Maxwell's equations, Fresnel equations, limitations of the electromagnetic description. (2 hours)

Optical systems – Fermat's principle, basic optical elements, matrix methods for optics, thick lens and their systems, determination of cardinal points, basic optical systems. (3 hours)

Polarisation – fundamentals, special devices – crystals, compensators, spatial light modulators, mathematical representations of polarised light. (3 hours)

Gaussian Beam Optics – beam propagation equation, beam properties and their characterization, matrix approach for Gaussian beam optics.   (2 hours)

Interferometry – principles and applications – fundamental concepts – conditions for interference, coherence theory elements, Young's double slit experiment, multiple-beam interference. Systems - Michelson, Twyman Green, Fizeau and other select configurations. Selected applications – e.g. metrology, sensors.   (4 hours)

Fourier Transforms in Optics – Foundational concepts and theorems, Fourier methods in diffraction theory, Abbe Porter's experiment, applications – e.g. optical waveshapers.
                    (3 hours)

Fibre optic systems – principles of guided wave propagation, basics of single mode and multimode, passive components, active components, fibre-optics based system design considerations, select applications – e.g. Dispersive Fourier Transformer, fibre optic sensors, imaging configurations.   (4 hours)

Nonlinear optics - Light-matter interaction and the nonlinear wave equation, second order nonlinearity - second harmonic generation, three-wave mixing, third order nonlinearity - third harmonic generation, four-wave mixing, Kerr nonlinearity and its applications.   (4 hours)

Detection of Optical Radiation – Time-domain methods: High speed detectors, Photomultipliers, Time of flight detectors, Cameras, characterization of ultrashort pulses. Spectral-domain methods – Essential components, resolving power of dispersive devices, the optical spectrum analyzer. Basics of quantum light – single photon generation and detection, applications – e.g. qubits. Full-field measurement techniques.   (4 hours)

Tutorial sessions – 10.
-   *Resource required* for tutorial sessions – Access to computer labs for numerical/computational solving of problems.

3. Text books:

Hecht, E., Optics, 4/e, Pearson.
Ghatak, A. K., & Thyagarajan, K., Optical Electronics, Cambridge University Press 2018.
4. References:

Saleh, B. E. A, & Teich, M. C., Fundamentals of Photonics, 2/e, Wiley Interscience 2007.

5. Similarity Content declaration with existing courses:

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	PH502	Electromagnetic theory; polarization; Detection of light; Guided wave optics.	Less than 40%

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

The discipline of focus of the presently proposed course is photonics, which is the same for the existing course PH502.

However, the emphasis of the presently proposed course is more on the applied nature of the topics discussed. It is designed with the goal that upon completion of the course, the students will be able to use the techniques learnt and apply them practically in their own labs and

experiments. To this end, student learning will be supported during tutorial sessions by looking at real-world systems and case studies. In addition, students will be required as part of their summative assessment to present a current topic of their choosing (vetted by the course instructor) as a poster to faculty and other scholars, who would adjudge their understanding of the material at par with working professionals on the field.

The existing similarities between the two courses primarily arise owing to the correspondence to fundamental concepts. Again, as highlighted above, the course content and approach taken will be one tailored towards applying the taught concepts, and transferring them to the student's own field of expertise.

Furthermore, the proposed course *includes 5 new topics*, viz. optical systems design, Gaussian beam optics, Fourier Transforms in Optics, Optical detection – spectral domain methods, and Nonlinear Optics. **These will serve to complement the existing PH502 course.**

The table below indicates the similarity content in 5 of the 10 topics of the presently proposed course. This table also serves to highlight inclusion of additional content within the similar topics, which underscore the applied ethos of the proposed course.

Similar content are indicated in blue –

PH502	This proposed course
Electromagnetic optics – Electromagnetic theory of light, electromagnetic waves in vacuum & dielectric media, absorption and dispersion, pulse propagation in dispersive media, Metamaterials	**Fundamentals of Electromagnetic theory of light** – complex representation of electromagnetic field disturbances, Maxwell's equations, Fresnel equations, limitations of the electromagnetic description.
Polarization optics – Polarization of light, reflection and refraction, optics of anisotropic media, Optics of liquid crystals, polarization devices.	**Polarisation** – fundamentals, special devices – crystals, compensators, spatial light modulators, mathematical representations of polarised light,
Guided wave optics - electromagnetic waves in dielectric layered media, photonic crystals, waveguides, resonators, plasmonics. & **Fiber Optics**: electromagnetic waves in fiber, Attenuation and dispersion, photonic crystal fibers & **Optical fiber communication**: fiber Optic components, optical fiber communication syatem, modulation and multiplexing, fiber optic networks.	**Fibre optic systems** – principles of guided wave propagation, basics of single mode and multimode, passive components, active components, fibre optics based design considerations, select applications – e.g. Dispersive Fourier Transformer, fibre optic sensors, imaging configurations.
Detection of light - theory of photo detection, photodetectors, photodiodes, avalanche photodiodes, noise in photodetectors.	**Detection of Optical radiation** - Time-domain methods: High speed detectors, Photomultipliers, Time of flight detectors, Cameras, characterization of ultrashort

	pulses. Spectral-domain methods – Essential components, resolving power of dispersive devices, the optical spectrum analyzer. Full-field measurement techniques.

Approvals:

Other Faculty interested in teaching this course: –

Proposed by: SRIKANTH SUGAVANAM   **School: SCEE**

Signature: *S. Sribee*   Date: 5/03/2021

Recommended/Not Recommended, with Comments:

_____   Date:_____
Chairman, CPC

Approved / Not Approved

_____   Date:_____
Chairman, Senate

IIT Mandi
Proposal for a New Course

Course No: IC-131

Course Name: Applied Chemistry for Engineers

Credits: 2-0-2-3

Prerequisites: None

Distribution: Institute core for B. Tech. (all Branches)

Preamble

Chemistry is the study of substances in terms of their composition, structure, properties and reactions. The course is designed as a blend of both theoretical and practical aspects in a complementary fashion. The objective of the course is to primarily reinforce the chemical concepts that the students have learned in school. However, the major focus would be to give a perspective on the application of those concepts in real life technologies. This course will replace the two existing courses, Applied Chemistry for engineers (IC130) and Chemistry practicum (IC130P).

Outline

Chemical bonding concepts will be discussed on the context of materials having different particles sizes and shapes. Spectroscopic principles and their technological applications in sensors, imaging devices, diagnostic tools will be discussed. Applications of electrochemical concepts in energy generation and storage devices will also be introduced.

Theory: [28 h]

Chemical bonding; MO theory; LCAO molecular orbitals; structure, bonding and energy levels of diatomic molecules, 3D, 2D, 1D and 0D materials. [7h]

Intermolecular Forces; Potential energy surfaces-Rates of reactions; Steady state approximation and its applications; Catalysis. [4h]

Spectroscopy- Introduction and classification; Basic principles, instrumentation and technological applications of - Ultra Violet-Visible Spectroscopy; Infra-Red Spectroscopy; Raman Spectroscopy; and Nuclear Magnetic Resonance Spectroscopy. [10h]

Electrochemistry and its applications in Fuel cells; Batteries; and Supercapacitors. [7h]

Lab: [28 h]

Experiments illustrating the concepts of:
1. Chemistry in real life: analysis of food, soil and water quality.
2. Synthesis of materials and their characterisation using analytical tools.
3. Electrochemistry.

Text Books

1. Engineering Chemistry by Wiley India Pvt. Ltd.
2. Engineering Chemistry by Shashi Chawla

Reference Books

1. Fundamentals of molecular spectroscopy by Colin Banwell and Elaine McCash, Tata McGraw Hill Education Pvt. Ltd.
2. Fundamentals of Electrochemistry, Second Edition by V. S. Bagotsky, John Wiley & Sons Inc, 2005

Proposed by: Committee (Dr. Prem Felix Siril, Dr. Anirruddha Chakraborty, Dr. Viswanath Balakrishnan, Dr. Sumit Sinha Ray, Dr. Amit Jaiswal)

School: SBS

Signature _Amit Jaiswal_____ Date_____

Recommended/Not Recommended, with Comments:

_____   Date:_____

Chairman, CPC

Approved / Not Approved

_____   Date:_____

Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number: EE560
Course Name: Reconfigurable Computing
Credits: 3-0-2-4
Prerequisites: EE 210/201P- Digital System Design & Practicum, CS 201/201P-Computer Organization & Practicum.
Intended for: PG/UG
Distribution: Elective for M. Tech (VLSI), UG and other PG courses

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1. Preamble: Application level parallelism in the new age computer architecture is gaining much attention with the recent achievements in the VLSI technology. Reconfigurable computers offer the advantage of configuring hardware and programming the interconnections as per the application in comparison to the fixed hardware elements (and interconnections) in a general purpose microprocessor. The aim of this course is to investigate the state-of-the-art in reconfigurable computing and motivating hardware-software co-design on FPGA. The concepts of reconfigurable computing will be validated with experiments on various numerical, signal processing and cryptographic algorithms.

2. Course Modules with Quantitative Lecture Hours: This course has three hour lecture session accompanied by two hours of laboratory session per week. List of course modules are provided below.

1. **Introduction to reconfigurable computing :** [3 Hours]
   Reconfigurable computing, history and survey, fixed Vs reconfigurable computing, applications of reconfigurable computing

2. **FPGA Design :** [6 Hours]
   Introduction to FPGA, LUT devices and mapping, partitioning, placement and routing algorithms. A case study on ALU design

3. **Reconfigurable computing architectures:** [5 Hours]
   Performance evaluation, Coarse grained and fine grained reconfigurable computing, a case study on coarse grained reconfigurable computing, Multi-FPGA architectures, Dynamic reconfiguration, total versus partial reconfiguration

4. **Reconfigurable computing :** [2 Hours]
   Power Reduction techniques for FPGA

5. **Reconfigurable computing applications** [6 Hours]
   Distributed Arithmetic, CORDIC algorithm on FPGA

6. **Reconfigurable computing – Security to FPGA** [4 Hours]
   Physical Unclonable Functions-Introduction and implementation on FPGA, on-chip authentication of FPGA-based devices

7. **Hardware-Software Co-design** [4 Hours]
   Introduction, Partitioning, Scheduling, Synthesis, Retiming, Pipelining. Unfolding, analysis and Estimation

8. **Finite State Machine with Datapath** [3 Hours]
   Introduction, finite state machines, finite state machine with datapath (FSMD), a case study on FSMD

9. **Hardware –Software Interfaces** [3 Hours]

Hardware software Communication, one way and two way handshake, blocking and non-blocking data transfer, On-chip Bus, Bus transfer and topologies

10. Case study [6 Hours]

Decoders, Crypto processor, CORDIC processor.

Experiments: The practicum of this course implements the FPGA based implementation of the algorithms and architectures discussed during the course. Experiments such as UART interfacing with FPGA, CORDIC algorithm, interfacing camera with FPGA, image compression and cryptographic algorithm on FPGA.

3. Textbooks:
1. Scott Hauck André DeHon, Reconfigurable Computing, The theory and practice of FPGA based Computation, 1st edition, Morgan Kaufmann, 2008.
2. F. Vahid and T. Givargis, "Embedded Systems: A Unified Hardware Software Introduction", John Wiley and Sons, 2011.

4. References:
1. Patrick Schaumont, "A Practical Introduction to Hardware/Software Co design", Springer, 2010, ISBN 978-1-4614-3736-9 and ISBN 978-1-4614-3737-6.
2. **Bobda**, Christophe, Introduction to Reconfigurable Computing: Architectures, algorithms and applications, Springer, 2007.
3. I. Koren, "Computer Arithmetic Algorithms". A.K. Peters Ltd., 2002.
4. Behrooz Parhami, "Computer Arithmetic- Algorithms and Hardware Designs", Oxford university press, 2nd Edition. 2010.
5. Peter J. Ashenden, "The designer's guide top VHDL", Morgan Kaufmann, 2008.
6. IEEE research papers on relevant topics.

Similarity Content Declaration with Existing Courses:

S.No	Course Code	Similarity content	Approximate %
1.	EE 529	Introduction to FPGA, Hardware Software co-design	< 20 %
2.	EE208P	Introduction to FPGA	< 5 %
3.	EE 523	CORDIC Based Architecture	< 10 %

Justification for new course proposal if cumulative similarity content is >30%: N/A
Approvals:
Other faculty interested in teaching this course: Dr. Rahul Shrestha, Dr. Shubhajit Roy Chowdhury

Proposed By: Dr. Srinivasu Bodapati
Signature: Date:
Recommended/Not Recommended, with comments:

_____Chairman, CPC

Approved/Not Approved

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Chairman, Senate
School: SCEE

IIT Mandi
Proposal for a New Course

Course Number	: ME 310
Course Name	: System Dynamics and Controls
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (IC110) and Linear Algebra (IC111)
Intended for	: UG
Distribution	: Discipline Core for ME
Elective or Core	: Core

Preamble: The objective of this course is to introduce students with fundamental concepts of modeling, analysis, and design of linear control systems for physical systems. Students will be taught applying modelling techniques to real physical systems and analyzing its performance and stability before building real systems. Performance and stability analysis will be done in time and frequency domain which will allow student to build linear controllers by applying classical and modern control techniques. Matlab/Simulink will be used to create models and design of controllers.

Course Outline: Modeling of mechanical, electrical, and electromechanical systems. Laplace Transform techniques. Time response analysis. Block diagram representation. Feedback systems. Root locus method. Frequency response techniques. State-space representation. Controller design.

Course Modules: In this course the student will develop and/or refine the following areas of knowledge:

- **Introduction [2 hrs]:** Control system examples, historical developments leading to modern day control theory, the basic features and configurations of control systems, control systems analysis and design objectives, control system's design process

- **Modeling in Frequency Domain [3 hrs]:** Mathematical descriptions of systems by differential equations, Laplace transform linear, time-invariant systems (mechanical, electrical, and electromechanical), linearization of a nonlinear system to find the transfer function.

- **Modeling in Time Domain [3 hrs]:** State-space representation a LTI system, conversion of a transfer function to state space and vice-versa, linearization a state-space representation.

- **Time Response [3 hrs]:** Effect of poles and zeros on the time response of a control system, quantitative description of the transient response of first-order systems, general response, damping ratio, settling time, peak time, percent overshoot, and rise time and natural frequency of second-order systems, time response from the state-space representation.

- **Reduction of Multiple Subsystems [2 hrs]:** Reduction of a block diagram of multiple subsystems to a single block, analysis and design of transient response for a system consisting of multiple subsystems, conversion of block diagrams to signal-flow diagrams, Mason's rule.

- **Stability [3 hrs]:** Making and interpreting Routh table to determine the stability of a system, Application of Routh table to determine the stability of a system represented in state space.

- **Steady-State Errors [2 hrs]:** Steady-state error for a unity feedback system, steady-state error performance, design the gain of a closed-loop system to meet a steady-state error

specification, finding the steady-state error for disturbance inputs, steady-state error for systems represented in state space.

- **Root Locus Techniques [4 hrs]**: Properties of a root locus, sketching techniques of a root locus, root locus for systems of order 2 and higher, root locus for positive-feedback systems.
- **Design via Root Locus [4 hrs]**: Use the root locus to design cascade compensators to improve the steady-state error and the transient response, feedback compensators to improve the transient response, realize the designed compensators physically.
- **Frequency Response Techniques [4 hrs]**: Plot of frequency response of a system, Nyquist stability criteria, gain and phase margins, closed-loop frequency response.
- **Design via Frequency Response [5 hrs]**: Use frequency response techniques to adjust the gain to meet a transient response specification, frequency response techniques to design cascade compensators to improve both the steady-state error and the transient response.
- **Design via State Space [5 hrs]**: State-feedback controller using pole placement, controllability, transient response specifications, observability.

Text Books:
- System Dynamics, 4th Edition by Katsuhiko Ogata, Pearson Education, 2013
- *Control Systems Engineering*, 7th Ed. by N. S. Nise, Wiley, 2015
- Control Systems: Principle & Design, 4th Ed. by M. Gopal, McGraw Hill, 2012

Suggested Books:
- Feedback Control Systems, Franklin, Powell
- The Mechatronics Handbook, Robert H. Bishop
- Modeling, Simulation, and Control of Mechatronic Systems, Dean C. Karnopp, Donald L. Margolis and Ronald C. Rosenberg, John Wiley & Sons, Inc.
- Control and Mechatronics, Bogdan M. Wilamowski and J. David Irwin, CRC Press
- Mechatronics Electronic control systems in mechanical and Electrical Engineering, William Bolton, sixth edition, Pearson

- Modern Control Systems, Richard C. Dorf and Robert H. Bishop, Pearson

Note: EE301 cannot be credited if ME310 has already been credited, due to the significant overlap.

Similarity content with existing courses:

S. No.	Course code	Similarity content	Approx. % of content
1	EE 301	Time-domain analysis, Frequency-domain analysis, Stability analysis, Root-locus technique, State-space Analysis	30%-40%

Justification for new course proposal if cumulative similarity content is > 30%:
In most of the universities around the world including IITs "System Dynamics and Control", with alternative names such as "Mechatronics and Control" or "Introduction to Control Systems", is a core course for the students of mechanical engineering. Mechanical engineering students must be familiar with techniques of control systems especially applied in the control of mechanical systems, electromechanical systems, and basic electrical systems for acquiring real proficiency in managing these systems used in industries. Aerospace

engineering and chemical engineering also teach similar control courses specific to their field to their students. Therefore, my proposal is that students of mechanical engineering should also learn this important course oriented to their engineering stream. Many students from mechanical engineering stream, who have not taken any course in control systems hesitate to take-up interest in robotics and related fields. Therefore, this course will not only introduce mechanical engineering students with basic control engineering but also prepare them to take-up further interest and required skill development in automation, mechatronics, robotics, and intelligent systems. Skill of the student with professional outcomes because of this course are listed as follows:

Student Outcomes:
An ability to apply knowledge of mathematics, science, and engineering.
An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
An ability to identify, formulate, and solve engineering problems
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Professional Outcomes: The most measurable long-term outcome from this course is the student's resulting ability to identify, formulate and organize engineering problems in a conceptual form as well as in terms of mathematical and physical models. Understanding control systems enables students from all branches of engineering to speak a common language and develop an appreciation and working knowledge of the other branches.

Approvals:

Other faculty interested in teaching this course: Dr. Rajeev Kumar, Dr. Gaurav Bhutani, Dr. Arpan Gupta

Proposed by: Dr. Amit Shukla

Signature:_____   Date:_____

Recommended/Not Recommended, with comments:

                                      Date: _____
_____
Chairman, CPC

Approved/Not Approved

                                      Date: _____
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Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number	:	ME 501P
Course Name	:	Practicum-I
Credits	:	0-0-6-3
Prerequisites	:	None
Intended for	:	Only for M.Tech.
Distribution	:	Core for M.Tech in Fluid and Thermal Engineering
Semester	:	Winter Break

Preamble - After completing one semester of course work at IIT Mandi, the students will be exposed to hands-on which will help to develop useful skills, through this course. This skill can include, performing numerical/experiment work in a laboratory, developing some models/products, literature survey, venturing into a new domain, testing the validity of a new idea through experimentation and/or numerical simulations etc. A laboratory will be allotted to every student. This course will end at the start of the even semester. **The Faculty Advisor (FA) will form a committee according to M.Tech. ordinance and conduct presentations to evaluate the work performed in this course.**

Course Modules with Quantitative Lecture Hours:

There are no regular lecture hours or practical classes for this course. It is expected that a student should meet laboratory coordinator regularly and perform the work as per mutual understanding between them.

The assigned work should provide exposure to students. It should help them in choosing relevant problems and defining its objectives. Students should perform small scale work for understanding the current level of development in the area of problem. Based on this they should make some effort for solving a few objectives by applying the learned numerical or experimental skills. Learning of any new skill before applying them should also be counted in the effort of the students.

3. Text Book:

There is no text book for this course.

4. Reference Books: N.A.

5: Similarity Content Declaration with Existing Course: N.A.

S.N	Course Code	Similarity Content	Approx. % of Content
1			

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

Not Applicable

Other Faculty interested in teaching this course: Pradeep Kumar
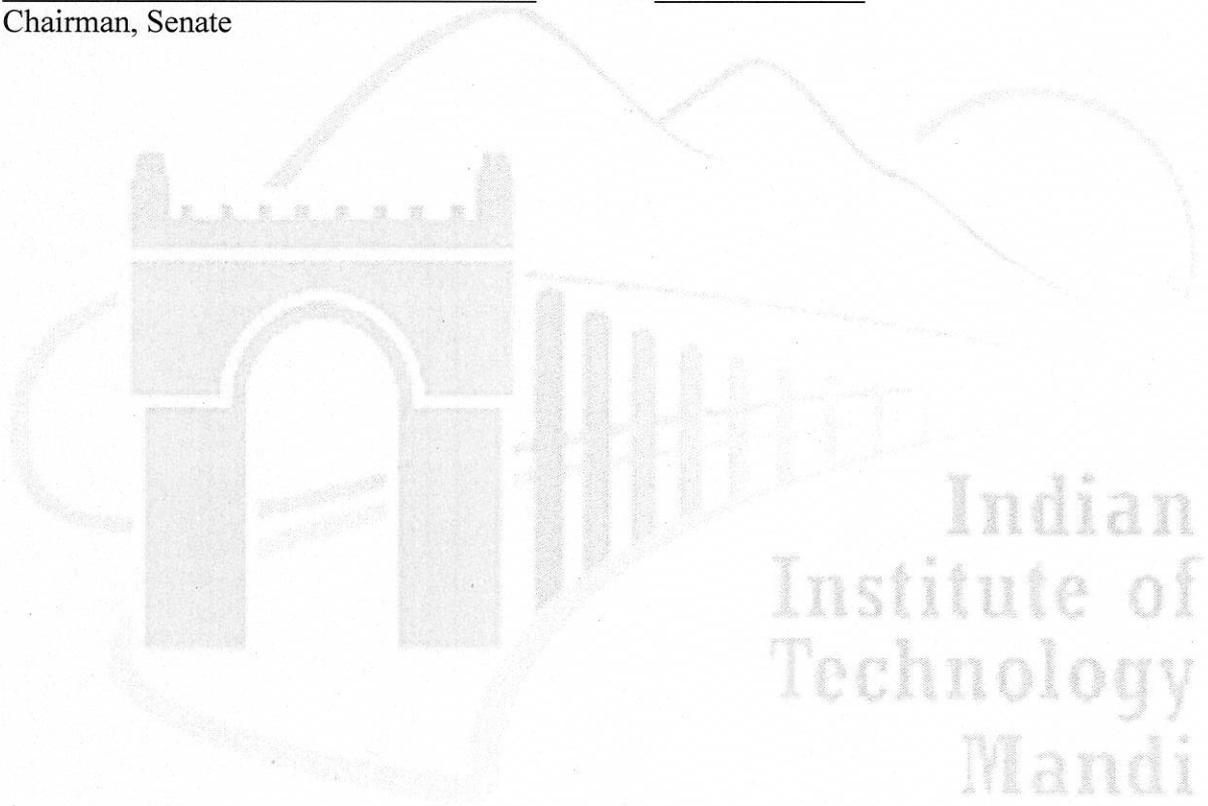
Proposed by: School: School of Engineering

Signature_____Date_____

Recommended/Not Recommended, with Comments:

_____   Date:_____
Chairman, CPC

Approved / Not Approved

_____   Date:_____
Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number	:	ME514
Course Name	:	Fundamentals of Multiphase Flow
Credits	:	3-0-0-3
Prerequisites	:	ME 210 and ME 303 or equivalent courses
Intended for	:	M.Tech/MS/PhD/UG
Distribution	:	Elective course

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1. Preamble:

Multiphase flow is often encountered in a variety of engineering applications such as power generation, nuclear reactor technology, food production, environmental flows, chemical process, aerospace and automotive industries. This course intends to extend the fundamental knowledge of multiphase flow which is a very vast area and has a wide scope in several fields of engineering. The course emphasizes the preliminary introduction and mathematical formulations of various multiphase flow problems. It also attempts to include the flow specific computational theories along with experimental measurement techniques so that students can be benefited to pursue the research in the relevant area. The last module of the course lists special topics in multiphase flow and the instructor is advised to select the topics and lecture distributions as per his/her interest.

2. Course modules with quantitative lecture hours:

- **Introduction and flow regimes [6hrs]**
  Introduction to multiphase flows, equations of motion, flow regimes in horizontal and vertical pipes, flow regimes with phase change
- **Modelling techniques for multiphase flow [12hrs]**
  Homogeneous flow models, drift flux models, separated flow models, dispersed phase modelling, modelling of annular and stratified flow
- **Computational techniques [10hrs]**
  Introduction to computational modelling of multiphase flow, population balance modelling for dispersed phase, interface tracking methods for multiphase flow (Volume of Fluid and Level set), particle methods for multiphase flow (Lagrangian Point Particle and Smoothed Particle Hydrodynamics), molecular dynamics
- **Experimental techniques [7hrs]**
  Introduction to experimental techniques, importance of measurement and experimentation, calibration, uncertainty analysis, error propagation, pressure, velocity and temperature measurements, measurement of size distribution for dispersed phase, measurement of void-fraction and interface reconstruction, data acquisition and analysis techniques
- **Special topics in multiphase flow [7hrs]**
  Granular flows, slurry transport, lattice Boltzmann method, phase change heat transfer, micro-fluidics, multiphase flow in micro-channels

3. Text books:

- Christopher E. Brennen, Fundamentals of Multiphase Flow, Cambridge University Press; 2005.
- S. Mostafa Ghiaasiaan, Two-Phase Flow, Boiling, and Condensation, Cambridge University Press; 2nd Edition, 2007.

4. References:

- John G. Collier and John R. Thome, Convective Boiling and Condensation, Oxford University Press; 3rd Edition, 1994.
- L. S. Tong and Y. S. Tang. Boiling Heat Transfer and Two-Phase Flow, CRC Press; 2nd Edition, 2010.
- R. Clift, J. R. Grace and M. E. Weber, Bubbles, Drops, and Particles, Dover Publications, Inc.; 2005.
- Mamoru Ishii and Takashi Hibiki, Thermo-Fluid Dynamics of Two-Phase Flow, Springer; 2nd Edition, 2011.
- J. P. Holman, Experimental Methods for Engineers, Tata McGraw-Hill; 7th Edition, 2001.
- Andrea Prosperetti and Grétar Tryggvason, Computational Methods for Multiphase Flow, Cambridge University Press, 2007.
- Grétar Tryggvason, Ruben Scardovelli and Stephane Zaleski, Direct Numerical Simulations of Gas-Liquid Multiphase Flows, Cambridge University Press, 2011.

5. Similarity content declaration with existing courses:

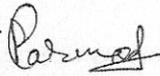| S. No.	Course code	Similarity content	Approx. % of content
1.	ME604	Introduction to experimental techniques, importance of measurement and experimentation, uncertainty analysis	5

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

Approvals:

Other faculty interested in teaching this course: Dr. Gaurav Bhutani

Proposed by: Dr. Parmod Kumar   School: SE
Signature:_____   Date: <u>18/05/2019</u>

Recommended/Not Recommended, with comments:

_____   Date: _____
Chairman, CPC

Approved/Not Approved

_____   Date: _____
Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number: ME 516
Course Name: Polymer Technology for Engineers
Credits: 3-0-0-3
Prerequisites: Materials Science for Engineers (IC241) or equivalent material science course
Intended for: UG/PG
Distribution: Elective for UG (ME), M Tech/MSc., MS, and PhD

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1. **Preamble:** Polymers or commonly known as plastics as commodity materials have been around for more than 50 years. In the 1950s, plastics were considered to be specialist materials for niche applications or were used by artists. With the greater availability of polymers in the 1960s, a number of engineers started to explore their application in a variety of areas- automobiles to aeroplanes, day- to-day utensils to biomedical implants and many more. Now plastics have found ways to become the most common material in our lives. For engineers to be able to successfully use plastics they need to recognise that, unlike metals, alloys and ceramics, the physical properties of polymers can vary significantly with stresses and temperature. This course will help students to identify the properties of polymers, and thereby engineer them according to the demands following several manufacturing technique.

2. **Course Outline:** The course will highlight different aspects polymer chemistry, mechanical and physical properties of polymers, common and advanced manufacturing techniques followed by several case studies with applications.

3. **Course Modules:**

Module-1: Introduction to Polymer (3 hrs)
Brief history of polymers; polymer classification; molar mass and molar mass distribution; polyethylene-polymerization process; chemical bonding- primary, secondary and tertiary structure; crystallinity

Module-2: Thermal Transitions in Polymers (4 hrs)
Glass transition temperature; factor affecting glass transition temperature- molar mass dependence, plasticization, chain entanglement effect; crystalline melting point; differential scanning calorimetry

Module-3: Mechanical Properties of Polymers (6 hrs)
Stress-strain measurements; dynamic modulus; methods of measurements of polymers- tensile testing, fracture, creep, relaxation time, compression; effect of structural and environmental factors on mechanical properties- molecular weight, cross-linking, crystallinity, strain rate, temperature.

Module-4: Viscoelastic Properties of Polymer (6hrs)
Simple rheological responses- ideal elastic, pure viscous and rubberlike elastic; viscoelasticity; mechanical models for viscoelastic responses- Maxwell model, Kelvin-Voigt model, Four-parameter model; relaxation time; material response time-Deborah number;

Module-5: Polymer processing- Melt: Thermoplastics and Thermoset (8 hrs)
Processing thermoplastics- rotational moulding, injection moulding, compression moulding; melt spinning; processing thermosets- hand lay-up process, spray lay-up method, vacuum bagging, resin transfer moulding, resin infusion process; dry spinning, Spun bonding

Module-6: Polymer processing- Solution: Thermoplastics   **(3 hrs)**
Electrospinning; centrifugal spinning; wet spinning

Module-7: Composites   **(3 hrs)**
Importance of composites; classification- fiber and particle reinforced; factors affecting composite performance; failure

Module-8: Case Studies   **(4 hrs)**
Application of polymers in special cases-vibration damping; energy; adhesives; bio-medical-drug delivery, tissue engineering; water and air purification; electronics

Module-9: Recycling of Plastics and Environmental Issues   **(3 hrs)**
Need of recycling: degradation-thermal, chemical, hydrolysis, mechanical; incineration; bioplastics; issues with recycling

4. **Text Books:**
    - Robert O. Ebewele, 2000, Polymer Science and Technology, CRC press.
    - Richard A. Pethrick, 2010, Polymer Science and Technology for Scientists and Engineers, Whittles Publishing

5. **Similarity Content Declaration with Existing Courses**

S.No.	Course Code	Similarity Content	Approx. % of Content
1.	CY 641	Classification, polymerization process (Here limited to one model case – Polyethylene compared to vast polymerization chemistry emphasized in CY 641)	Less than 5%
2	CY 555	History of Polymers, Molecular weight, Glass transition temperature, Physical state of polymers, DSC, Polymer fibers	Less than 10%

6. **Justification for new course if cumulative similarity content is > 30%:** Not Applicable

Other Faculty interested in teaching this course: Dr. Sunny Zafar, Dr. Swati Sharma, Dr. Jaspreet Kaur Randhawa

Proposed by: Dr. Sumit Sinha Ray   School: SE

Signature_____Date_____

Recommended/Not Recommended, with comments:

_____   Date: _____
Chairman, CPC

Approved/Not Approved

_____   Date: _____
Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number	:	ME627
Course Name	:	Mesh Independent Computational Techniques
Credits	:	3-0-0-3
Prerequisites	:	FEM in Engineering (ME 513)/Advanced FEM (ME 601)
Intended for	:	M.Tech/MS/PhD/UG
Distribution	:	Elective course

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1. Preamble:

In recent years, many mesh independent numerical methods have been developed to simulate problems with geometrical discontinuities or moving boundaries and highly oscillatory systems. Many challenging engineering problems such as solidification, microstructure modelling, material interfaces, bio-mechanics, fracture and fatigue, and asymptotic field problems can be solved much more easily with improved accuracy using the mesh independent methodology. This course describes the need and scope of mesh independent methods like meshfree methods and eXtended finite element method. The course emphasizes the preliminary introduction and mathematical formulations of various mesh independent computational techniques. It also attempts to include the implementation to specific engineering problems so that students can be benefited to pursue the research in the relevant area. This course focuses on various aspects with particular reference to application and implementation of methodology by using computer programming.

2. Course modules with quantitative lecture hours:

- **Scope and Need of Mesh Independent Methods   [9 hrs]**
  Equations for two-dimensional and three-dimensional solids, Strong-forms and weak-forms, Weighted residual method, Need of Mesh free methods, Solution procedure of MeshFree methods, Classification according to the formulation procedures, Classification according to the function approximation schemes.

- **Shape function construction [6 hrs]**
  Meshfree shape function construction, Point interpolation methods, Moving least squares shape functions, Interpolation error using Meshfree shape functions.

- **Methods based on global weak-forms [8 hrs]**
  Meshfree radial point interpolation method and formulation, Integration issues in RPI method, Imposition of essential BC in RPI method, Element Free Galerkin method formulation and shape function, Implementation issues and application examples in EFGM, Integration techniques and enforcement of BC in EFGM.

- **Methods based on local weak-forms [4 hrs]**
  Meshless Local Petrov-Galerkin method, Implementation issues and application examples.

- **eXtended Finite Element Method [6 hrs]**
  Difference between FEM and XFEM, Partition of Unity and Level set function, Intrinsic enrichment and Extrinsic enrichment, Numerical integration, Implementation and case studies.

- **Computer Implementation and Case Studies [9 hrs]**

FEM implementation with computer programming platform.

Implementation of meshfree EFGM using computer programming for analysis of (i) solid mechanics problem (ii) heat transfer problem. Enforcement of essential boundary condition will be implemented using Lagrange multiplier method.

Implementation of XFEM with extrinsic enrichment techniques for material discontinuity and crack discontinuity.

3. Text books:

- An Introduction to Meshfree Methods and their Programming, *G.R. LIU and Y.T. GU,* ISBN-13 978-1-4020-3468-8 Springer Dordrecht, Berlin, Heidelberg, New York. 2005.
- Extended Finite Element and Meshfree Methods, Timon Rabczuk, Jeong-Hoon Song, Xiaoying Zhuang, Cosmin Anitescu, ISBN: 9780128141069, Academic Press Elsevier, USA. 2019.

4. References:

- Meshfree Methods: Moving Beyond the Finite Element Method, *G.R. LIU,* ISBN 9781420082098 CRC Press Taylor and Francis Group, USA. 2018.
- Meshfree Methods for Partial Differential Equations, Lecture Notes in Computational Science and Engineering book series, Springer, Berlin, Heidelberg. 2017.
- Meshless Methods in Solid Mechanics, Youping Chen, James Lee, Azim Eskandarian, ISBN 978-0-387-30736-7, Springer, New York, USA. 2006.
- Meshless Methods and Their Numerical Properties, Hua Li, Shantanu S. Mulay, ISBN 9781138072312, CRC Press, Boca Raton, Florida, USA. 2013.
- Extended finite element method for Fracture Analysis of Structures, Soheil Mohammadi, ISBN: 978-1-4051-7060-4 Blackwell Publishing Inc., USA. 2008.
- Extended Finite Element Method: Theory and Applications, Amir R. Khoei, ISBN: 9781118457689, John Wiley & Sons. 2014.

5. Similarity content declaration with existing courses:

Sl. No.	Course Code	Similarity Content	Approximate % of Content
1	ME352	Strong-forms and weak-forms, Weighted residual methods	5 %

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

Approvals:

Other faculty interested in teaching this course: Dr. Rajeev Kumar, Dr. Rajesh Ghosh

Proposed by: Dr. Himanshu Pathak   School: School of Engineering (SE)

Signature: Date:

Recommended/Not Recommended, with comments:

                                                    Date: _____

_____

Chairman, CPC

Approved/Not Approved

                                                    Date: _____

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Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number	:	ME628
Course Name	:	Impact Mechanics
Credits	:	3-0-0-3
Prerequisites	:	Mechanics of Solids (ME206) &
		FEM in Engineering (ME513) or Advanced FEM (ME601)
Intended for	:	M.Tech/MS/PhD/UG
Distribution	:	Elective course

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1. Preamble:

Impact Mechanics is an advanced course under mechanical engineering for students with specialization in machine design. The course covers theories for materials and structures subjected to transient dynamic loads such as impact, penetration and explosion. A key part of the course will be devoted to applied use of analytical methods in combination with explicit non-linear finite element analysis for solving this kind of problems. The course introduces principles, theory and techniques for analysis of impacts of particles and rigid bodies. Applications will be taken from vehicular crash mechanics to ballistic impact.

2. Course modules with quantitative lecture hours:

- **Introduction [4 hrs]**
  Impact Mechanics – Appreciating Impact Problems in Engineering, Historical Background, Low velocity impact, Principle of dynamics, Percussion, Concussion, Collision and Explosion.

- **Rigid Body Impact Mechanics [5 hrs]**
  Impulse – Momentum Equations, Measurement of Coefficient of Restitution, Kinetic Coefficient of Restitution, Energy Coefficient of Restitution, Oblique Impact – Role of Friction.

- **Impact Mechanics of Deformable Bodies [8 hrs]**
  One-Dimensional Impact Mechanics of Deformable Bodies: Single Degree of Freedom Idealization of Impact Process, 1-D Wave Propagation in Solids Induced by Impact, Governing Equation for Flexural Waves in Rods, D'Alembert's Solution for Wave Equation.
  Multi-Dimensional Impact Mechanics of Deformable Bodies: Analysis of Stress and Strain, Linearised Stress-Strain Relations.

- **Experimental Impact Mechanics [10 hrs]**
  Quasi-Static Material Tests, Pendulum Impact Tests, High Strain Rate Testing of elastoplastic and visco-elastic materials, Split Hopkinson's Pressure Bar Test, Taylor Cylinder Impact Test, Drop Impact Test.

- **Impact Modeling [6 hrs]**
  Modeling Deformation and Failure Under Impact: Equation of State, Gruneisen Parameter and Murnaghan Equation of State, Constitutive Models for Material Deformation and Plasticity, Johnson–Cook Material Model, Determination of Parameters in Johnson–Cook Model, Implementation of Damage, Implementation of penetration and bulging.

- **Computational Impact Mechanics [3 hrs]**
  Lagrangean Formulation, Eulerian Formulation, Computational Aspects in Numerical Simulation, Shockwaves.
- **Case Studies [7 hrs]**
  low-velocity impact properties of composite materials, Simulation of Ballistic Impact of a Steel Bullet, Mechanics of Vehicle Collision, Case studies of vehicle crash impact test, Case studies of explosive impact test.

3. Text Books:
- Applied Impact Mechanics, C. Lakshmana Rao, V. Narayanamurthy, K. R. Y. Simha, ISBN: 978-1-119-24180-5, John Wiley & Sons Ltd United Kingdom. 2016.
- Impact Mechanics, W. J. Stronge, ISBN: 9780511626432, Cambridge University Press United Kingdom. 2018.

4. References:
- Computational Contact and Impact Mechanics, Laursen, Tod A, ISBN 978-3-662-04864-1 Springer. 2003.
- The Science of Armour Materials, Ian G. Crouch, ISBN: 978-0-08-100711-2 Elsevier. 2016.
- Wave Motion in Elastic Solids, Karl F. Graff, ISBN: 978-0486667454, Dover Publications. 2003.
- Terminal Ballistics, Zvi Rosenberg and Erez Dekel, ISBN: 978-981-10-0393-6, Spinger. 2012.
- High Velocity Impact Dynamics, Jonas A Zukas, ISBN: 978-0471514442, John Wiley & Sons. 1990.

5. Similarity content declaration with existing courses:

Sl. No.	Course Code	Similarity Content	Approximate % of Content
1	IC240	Impulse – Momentum Equations	2%
2	CE511	Dynamic equilibrium equations	1%
3	ME614	Shockwaves	1%

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

Approvals:
Other faculty interested in teaching this course: Dr. Rajesh Ghosh, Dr. Mohammad Talha

Proposed by: Dr. Himanshu Pathak   School: School of Engineering (SE)
Signature: Date:

Recommended/Not Recommended, with comments:

_____   Date: _____
Chairman, CPC

Approved/Not Approved

_____   Date: _____
Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course number : CS514

Course name : Data Structures and Algorithms-II

Credits : 3-0-2-4

Prerequisites : CS-202 (DSA) or equivalent for UG students, None for PG students

Intended for : BTech (Semester 5 or 6) who have not taken CS403, MTech (CSE), MS, PhD

Distribution : Discipline Core for MTech CSE, Elective for UG CSE/DS, MS/PhD

Semester : Odd/Even

1. Preamble

The proposed elective course, building on top of the course on Data Structures and Algorithms (CS202), offers formal introduction to various common algorithm design techniques, methods for analyzing the performance of corresponding algorithms and improving their efficiency, and to provide performance guarantees.

The theoretical aspects of this course are going to be supplemented by comprehensive practice exercises and weekly programming labs worth one lab credit.

2. Course modules

1. Review of Data Structures from CS202: Asymptotic Notations, Solving recurrences, Insertion Sort, Merge Sort, QuickSort (3 H)
2. Advanced topics in Sorting and Searching:- Randomized Data Structures Treaps, Hashing, AVL Trees, Bucket Sort. (6 H)
3. Dynamic Programming (3 H)
4. Amortized analysis: aggregate analysis, accounting, potential method (3 H)
5. Graph Algorithms: Single-Source Shortest Paths Bellman Ford, All-Pairs Shortest Paths using Floyd Warshall, Maximum Flow (Ford Fulkerson) (6 H)
6. Advanced Data Structures: Quake heaps, van Emde BoasTrees, Union Find Data structures (6 H)
7. Computational complexity: Problem classes: P, NP, NP-complete, NP-hard. Reduction. Cook's theorem. Examples of NP-complete problems. (6 H)
8. Approximation Algorithms:- Greedy and Local Search algorithms, DP Algorithms (3 H)

9. Parameterized Complexity:- Introduction to FPT, Bounded Search Trees, Kernels
10. Additional Topics:-
    Streaming Algorithms:- Misra Gries, Count–min sketch, LSH, lossy count algorithm   (3 H)
    Comp. Geometry:- Convex Hull, Line segment intersection, Voronoi Diagrams   (3 H)
11. Coding Lab which covers topics discussed in this course   (28H)

3. Textbook

1) T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, Introduction to Algorithms, MIT Press, 3/e, 2009.
2) J. Kleinberg and E. Tardos, Algorithm Design, Pearson, 2006.

4. Reference books

1) S. Dasgupta, C. H. Papadimitriou, U. V. Vazirani, Algorithms, McGraw-Hill, 2006.
2) S. S. Skiena, The Algorithm Design Manual, Springer, 2/e, 2008

5. Similarity content declaration with existing courses:

	Course Name	Common Topic(s)	Overlap (%)
CS202	Data Structures and Algorithms	Hashing and Heap related concepts	Less than 10%
CS403	Advanced Data Structures & Algorithms	Several common topics	More than 30%

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

This course is proposed as a core course for MTech (CSE) and BTech students shall also be allowed to credit the same. The overwhelming overlap of contents (with CS403) is deliberate because we intend to discontinue offering CS403 starting from the winter session of 2021. Some parts of CS403 have either been covered in CS202 or are not relevant to the currently trending research areas. We compensate for these topics by adding new topics which we feel are best suited for the students and this upgrade in coursework also makes this course suitable for M.S., M.Tech and Ph.D. candidates.

Approvals:

Other faculty members who may be interested in teaching this course: Dr. Rameshwar, Dr. Satyajit

Proposed by: Dr. Varunkumar Jayapaul   School: SCEE

Signature: _____   Date: _____

Recommended/Not Recommended, with Comments:

_____   Date: _____
Chairman, CPC

Approved / Not Approved

_____   Date: _____
Chairman, Senate

IIT Mandi
Proposal for a New Course

Course number   : CS515

Course name   : Advanced Computer Science Practicum

Credits   : 2-0-2-3

Prerequisites   : UG level courses on Computer Networks, Operating
                              Systems, Databases, Computer Organization and Compilers

Intended for   : MTech (CSE), MS, PhD

Distribution   : Discipline Core for MTech CSE, Elective for others

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1. Preamble

The CSE MTech program envisions to train students in the skill-set required to work on large problems. Though courses such as operating systems, databases, networks, computer architecture and compilers are typically a part of all BTech CSE curriculums, students joining IIT Mandi after clearing GATE may have differing backgrounds when the practical experience with these courses is concerned. The objective of this course is to fill this gap and bring all MTech CSE students on the same page with respect to hands-on experience with some of the standard tools and techniques in designing computer systems, with a hope that this will help them perform well in all other practicum-based courses in future.

2. Course modules

1. Databases: Assignment on implementing an end-to-end system involving database backend, front-end web-based visualization and using database queries, joins, procedures, triggers, views, cursors, and transactions. Possible problems include:

[8 hours]

- Create a backend database application with a front-end web-based visualization that plots dependent variables of interest.
- Create a front-end website with the ability to register and authenticate users with respect to usernames and passwords; write a trigger on a table in a database that allows us to back-up the deleted entries in the table; write other complex queries involving joins on multiple tables.

2. Operating Systems: Assignments on understanding practical aspects of synchronization and implementing kernel modules in Linux. Modules allow extending the function of the kernel without rebooting the system. This assignment will introduce the students to implementing simple modules, their compilation and also tools for debugging kernels.

[8 hours]

3. Computer Networks: Assignments that involve socket programming, and protocol analysis by using network simulators. [8 hours]

4. Compilers and Architecture: Assignments that involve understanding the mapping of a high-level program down to a machine. The idea would be to familiarize students with the nuances of the connection between translating a high-level program and the machine on which it is executed. The assignments could be a subset of:

[16 hours]

- Writing a translator for converting programs written in a small programming language to an intermediate representation.
- Writing an interpreter for evaluating expressions/statements in a (small) programming language.
- Writing a register allocator for a given reference architecture.
- Writing an assembler that translates programs in an intermediate representation to the assembly for a given architecture.

5. Mini-project on designing scalable systems for different applications. This project will follow software engineering principles of project management, will emphasize scalable design principles, and involve performance analysis. [16 hours]

4. Reference books

1) Linux Device Drivers, Third Edition by Jonathan Corbet, Alessandro Rubini, and Greg Kroah-Hartman, O'Reilly Media, 2005.
2) Operating Systems: Three Easy Pieces by Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, Arpaci-Dusseau Books, August, 2018 (Version 1.00).
3) Computer Networking: A Top-Down Approach,by Kurose and Ross, (6th edition), Pearson 2013.
4) Modern Compiler Implementation in Java, Second Edition, by Andrew W. Appel and Jens Palsberg, Cambridge University Press, 2002.
5) Elmasri, R., & Navathe, S. B. (2015). Fundamentals of Database Systems (7th edition). London, UK: Pearson Education, UK.

5. Similarity content declaration with existing courses:

Course Code	Course Name	Common Topic(s)	Overlap (%)
CS 207	Applied Database Practicum	Database queries, cursors, triggers, and stored procedures	20%
CS309	System Practicum	Scalable system design	20%
CS 310	Introduction to Communicating Distributed Processes	Certain concepts in operating systems and networking	15%
CS502	Compiler Design	IR generation, register allocation	10%

Proposal for a New Course

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

This course is proposed as a core course for MTech (CSE) and BTech students will not be allowed to credit the same. The overlapping contents are essentially with various BTech core courses, and thus the intended audience is completely different.

Approvals:

Other faculty members who may be interested in teaching this course: Dr. Sriram Kailasam, Dr. Aditya Nigam, Dr. Varun Dutt, Dr. Arti Kashyap, Dr. Sreelakshmi PM

Proposed by: Dr. Manas Thakur, Dr. Aditya, Dr. Varun, and Dr. Sriram   School: SCEE

Signature: _____   Date: _____

Recommended/Not Recommended, with Comments:

_____   Date: _____
Chairman, CPC

Approved / Not Approved

_____   Date: _____
Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Name   :   Computational Methods for Engineering
Course Number   :   EP302
Credits   :   2-0-2-3
Prerequisites   :   IC110 Engineering Mathematics
Intended for   :   UG
Distribution   :   Core
Semester   :   Odd/Even

Preamble: Computational Methods are becoming an important tool of industrial design and development and so, it is necessary to train the students in these techniques. Computational Methods have been matured over the years with its own body of knowledge, theory, and research methodology. At the core of the discipline is the realization that every system can be represented by differential equations, the computational methodology can be helpful to analyses physical system in virtual domain. This course objective is to impart computational and numerical solving skills to students for the purpose of design analysis of multi-physics systems. This course focuses on various aspects with particular reference to application and implementation of computational methodology by using computational software package.

Course Modules with Quantitative Lecture Hours:
Module 1: (14 hours)
Numerical Techniques: Linear Equations and Non-linear Equations.
Solving Linear Systems: Gauss Elimination, Gauss-Jordan; LU Decomposition.
Solving Linear System with iterative methods: Jacobi method, Gauss-Seidel Method, Successive Over Relaxation (SOR) method.
Finding roots of polynomial and transcend equations:bisection method, Newton-Raphson method.
Numerical Integration: Trapezoid Rule, Simpson's Rule, Gaussian Quadrature.
Case study from multi-physics systems,Computer implementation.

Module 2: (6 hours)
FEM Concept: Introduction, Engineering applications of finite element method,Weak formulation, Interpolation scheme, FEM formulation for 1D and 2D problems, Computer implementation issues, Convergence and Error analysis.

Module 3: (5 hours)
FEM for Multi-Physics Systems: Case study of thermo-mechanical systems, electro-mechanical systems, thermo-electro-mechanical systems.

Module 4: (3 hours)
Simulation of Engineering Systems: Monte-Carlo simulation, Simulation of continuous and discrete processes with suitable examples from engineering problems.

Laboratory sessions:

Exp. 1 & 2 Use of numerical techniques to solve system of equations using computer programming platform.

Exp. 3&4 Introductions to computational software (FEM based packages).

Exp. 5,6 & 7 Find the simulation response of a physical system under (i) Mechanical load (ii) Thermal load (iii) Electrical load environment.

Exp. 8 & 9 Use of computational (FEM based) package to simulate multi-physics systems case e.g. Electric motor under electro-mechanical and thermal environment.

Exp. 10 & 11 Monte Carlo simulation.

Text books:

Reddy J. N., An introduction to Finite Element Methods, 3rd Ed., Tata McGraw-Hill, 2005

Steven C. Chapra and Raymond P. Canale, Numerical methods for engineers, 4th Edition, McGrawHill. 2015

References:

S D Conte and C de Boor, Elementary numerical analysis: algorithmic approach, 3rd Edition McGraw-Hill International, 1980.

Reuven Y. Rubinstein, Simulation and the Monte Carlo Method, 2nd Edition,,Wiley, 2007.

I. M. Smith, D. V. Griffiths, L. Margetts, Programming the Finite Element Method, 5th Edition, Wiley. 2013.

Anju Khandelwal, Numerical Methods and Computer Programming, 4th Edition, Alpha Science International Ltd. 2015.

Similarity content declaration with existing courses:

Sl. No.	Course Code	Similarity Content	Approximate % of Content
1	ME504	Partially Module 1	10%
2	PH621	Partially Module 1	5 %
3	ME513	Partially Module 2	5 %

Justification for new course proposal if cumulative similarity content is > 30%:
NA

Approvals:
Other faculty interested in teaching this course:

Proposed by: PFG-EP, Dr. Himanshu Pathak School:
Signature: Date:

Recommended / Not Recommended, with comments:

Chairman, CPC   Date:

Approved / Not Approved:

Chairman, Senate   Date:

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number	: EP403
Course Name	: Physics of atoms and molecules
Credits	: 3-0-0-3
Prerequisites	: PH301and/orfaculty consent. Out of EP403 and PH524, a student is allowed to take only one course.
Intended for	: B.Tech.
Distribution	: Core course for B.Tech. in Engineering Physics and elective for others.
Semester	: Odd/even

Preamble: This course introduces the basic ideas of working of physics at atomic and molecular level for practical applications and is founded on the basic quantum mechanics course. It teaches students how to apply quantum mechanics and extract information from many-electrons atoms and molecules.

Modules:

1.Time-independent perturbation theoryfor first and second-order correction and its application; Identical particles, eigen functions for identical two particle systems. [6 Hours]

2. Time-dependent perturbation theoryfor two level systems and it generalization to higher level systems, its application to Fermi-Golden rule.   [6 Hours]

3. Interaction of electromagnetic radiation with single electron atoms,Sinusoidal perturbation and Rabi flopping, Dipole approximation and dipole selection rules, Transition rates, Line broadening mechanisms,Incoherent perturbations, spontaneous and stimulated emissions and Einstein coefficients, selection rules for transitions   [12 Hours]

4.Review of atomic structure of H, Atomic structure of two electron system-variational method, central field approximation, Slater determinant, L-S coupling, J-J coupling.[7 Hours]

5.General nature of molecular structure, molecular binding, LCAO, Born-Oppenheimer Approximation.   [5 Hours]

6. Introduction to infra-red and Raman spectroscopy, Introduction to group theory and symmetry and Spectroscopy.   [6 Hours]

Textbooks:
1. Atomic Physics, C. J. Foot (Oxford, First edition 2005)
2. Fundamentals of molecular spectroscopy- C. Banwell and E. Maccash (Mc Graw Hill, 2013)

References:
1. Atoms, Molecules and Photons - Wolfgang Demtroder (Springer, Second edition, 2006)

2. Group theory and Quantum Mechanics - M. Tinkham (Dover Publications, First edition, 2003)
3. Physics of atoms and molecules - Bransden and Joachain (Pearson, second edition, 2011)
4. Advances in Atomic Physics - Claude Cohen-Tannoudji and David Guéry-Odelin (World Scientific Publishing Company, 2011).
5. Introductory Quantum Mechanics, R.L. Liboff, Addison-Wesley (2002).

1. Similarity Content Declaration with Existing Courses

S.N.	Course Code	Similarity Content	Approx. % of Content
1	PH524		35-40%

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

This course has content similarity to that of course titled PH524 which is a core course for master students. However, this course is specifically intended for B.Tech. EP students and designed for that purpose with special focus on applications. A student cannot take these two course to complete his/her degree.

Proposed by: Dr. Pradeep Kumar   School: SBS

Signature: _____   Date: _____

Recommended/Not Recommended, with Comments:

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Chairman, CPC

Approved/Not Approved

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Chairman, Senate

Proposal for a New Course

IIT Mandi
(Modification in course credit distribution)

Course Number	**:** EE528
Course Name	**:** Modelling and Analysis of Electrical Machines
Credits	**:** 2-0-2-3 (L-T-P-C)
Prerequisites	**:** EE 201 and EE201P - Electromechanics Theory and Laboratory/ Instructor Consent
Intended for	**:** BTech/M.Tech./MS/PhD
Distribution	**:** Core course for M. Tech. in Power Electronics and Drives, Elective forBTech, MTech, MS, PhD
Semester	**:** Odd

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1. Course Preamble:

This is a fundamental modelling and analysis course for electrical machines. This course will focus on design-oriented analysis of conventional and advanced electrical machines. Analytical concepts discussed in the course are intended to strengthen thefundamental understanding of electromechanical systems, and also to provide a basic framework for control of electric drives. This course will be helpful for students interested in doing projects in this field. It is recommended that the students opting for this course should have the basic knowledge of Electromechanics.

2. Course Modules with quantitative lecture hours:

Module1: Basic Principles of Electric Machine Analysis   (4 hours)

1. Review on basic magnetic circuits and electromagnets including analysis of magnetic circuits with airgap and permanent magnets.

2. Principle of Electromagnetic Energy Conversion

3. Basic Two pole DC Machine – primitive 2 axis machine -Voltage and Current relationship – Torque equation

Module2: DC Machine Modeling   (5 hours)

4. Mathematical modeling of D.C. Machine (Separately Excited, shunt and series type)

5. Linearization of machine equations and state space modeling of the machine

Module3: Induction Machine Modeling   (9 hours)

6. Distributed Winding in AC Machinery, winding function, air gap mmf, rotating mmf. Calculation of self and mutual inductances

7. Reference frame theory, stator and rotor voltage equations and torque equation in different reference frames, Linearized machine equations and Eigenvalue analysis, Derivation of model for steady-state analysis

Proposal for a New Course

8. Derivation of induction motor model in rotor fluxand stator flux oriented reference frame

Module4: Synchronous Machine Modeling   **(4 hours)**
9. Voltage and torque equations of salient pole synchronous machine including damper winding in stator and rotor reference frames

10. Derivation of steady state model

Module5: Permanent Magnet Machine Modeling   **(6 hours)**
11. Modeling of sine-wave and square-wave machines

12. Voltage and torque equations of surface-mounted permanent magnet machine in stator and rotor reference frames

13. Derivation of steady state model

Modeling and Simulation Lab. Sessions:

- Introduction to software's

- Mathematical modeling of simple circuits & systems

- Mathematical modeling of D.C. machines

- Reference frame theory

- Induction machine modelling in different reference frames including saturation effects

- Induction machine modelling for steady-state analysis

- Synchronous machine modelling in different reference frames including saturation effects

- Synchronous machine modelling for steady-state analysis

- Permanent magnet synchronous machine modelling

- Brushless DC machine modelling

3. Textbooks
1. Paul C. Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electric Machinery and Drive Systems" John Wiley and Sons, 2ndEdition, 2006.

2. CheeMunOng, Dynamic Simulation of Electric Machinery, Prentice Hall, 1997 (https://in.mathworks.com/matlabcentral/fileexchange/9941-dynamic-simulations-of-electric-machinery-using-matlab-simulink)

Proposal for a New Course

3. R Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press; 2009.

4. References

1. NPTEL Videos: Advanced Electric Drives by Prof. S P Das(https://nptel.ac.in/courses/108/104/108104011/#)

2. NPTEL Videos: Modelling and Analysis of Electric Machines, by Prof. K. Vasudevan(https://nptel.ac.in/courses/108/106/108106023/)

3. Bimbhra P.S., "Generalized Circuit Theory of Electrical Machines", Khanna Publishers Limited, 5th Edition, New Delhi, 2000.

4. B. K. Bose, "Modern Power Electronics and AC Drives", PearsonEducation, 2015

5. R Krishnan, "Electric Motor Drives – Modelling, Analysis and Control", Pearson Education, 2015.

6. P.Vas, Vector Control of A.C. Machines, Clarendon Press, Oxford 1990.

Other Faculty Members interested in teaching this course: Dr. Bharat Singh, Dr. Pratim Kundu, Dr. Himanshu Misra, Dr. Narsa Reddy

Proposed by: **Dr. Bharat Singh**   School: **SCEE**

Signature_____Date_____

Approved / Not Approved

_____   Date:_____
Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number	:	ME517
Course Name	:	Advanced Analytical Techniques for Engineers
Credits	:	3-1-0-4
Prerequisites	:	None
Intended for	:	UG/MTech/MS/PhD in engineering streams.
Distribution	:	core for M.Tech students in Fluid and Thermal Engineering
Semester	:	Odd/Even

1: Preamble: The present course is proposed as a core course in Fluid and Thermal Engineering (FTE) MTech program to develop a strong background in analytical (mathematical) techniques that are required in the various other core and elective courses in the program. The courses, which will benefit from the course on analytical techniques include, but are not limited to, advanced fluid dynamics, convective heat transfer, conduction and radiation, advanced thermodynamics, and computational fluid dynamics.

2: Course modules with quantitative lecture hours:

- Integral Transforms: Fourier transform for solution of ODEs and PDEs, Laplace transform for solution of ODEs and PDEs. [6hrs]
- Partial Differential Equations: solution of linear PDEs including special cases of heat conduction equation and Navier--Stokes equation, solution of PDEs in cylindrical and spherical coordinate systems. [10hrs]
- First-order integral equations: Fredholm, Volterra and Wiener-Hopf equation, power series solution for integral equations, integral equations as a generalization of eigenvalue equations and connection to inverse problems [6hrs]
- Tensors: Einstein notation, tensor transformations, tensor fields and tensor calculus, integral theorems. [6hrs]
- Complex analysis: functions of a complex variable, limits and continuity, analytic functions, complex exponents, contour integrals, Cauchy integral formula, complex series, Chauchy's residue theorem, singularity, zeros and poles, improper integrals in Fourier analysis, application to plane fluid flow and signal processing. [8hrs]
- Linear Algebra: spaces and subspaces, positive definiteness and singular value decomposition (best basis), transformations and change of basis, pseudoinverse, eigenvalues and eigenvectors, introduction to multigrid, Krylov subspaces and conjugate gradients methods for solving large linear systems. [10 hrs]

- Statistical Methods: probability, random variables, discrete and continuous probability distributions, autocorrelation and cross correlation, Monte-Carlo method for the solution of diffusion equation, radiative transfer equation and collimated beam radiation problem; linear regression and curve fitting.   [10 hrs]

3: Text Books:

1. B. Dasgupta, Applied Mathematical Methods, Pearson Education, 2006.
2. Sheldon M Ross, Probability and Statistics for Engineers and Scientists, 5/e, Academic Press, 2014.

4: References:

1. M D. Greenberg, Advanced Engineering Mathematics, 2nd Edition, Pearson India, 2007.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, International 10th Revised Edition, 2015.
3. G. Strang, Linear Algebra and Its Applications, Thomson, Brooks/Cole, 2006
4. P. V. O'Neil, Advanced Engineering Mathematics, CENGAGE Learning,, 2011.
5. R. L. Thomas and G. B. Finney, Calculus and Analytic Geometry, 11/e Addition-Wisley Reading, 2010.
6. M. L. Boas, Mathematical Methods in the Physical Sciences, 3rd Ed, Wiley India, 2009.
7. A. D. Polyanin and A. V. Manzhirov, Handbook of Integral Equations, Second Edition, Chapman & Hall/CRC Press, Boca Raton, 2008.

5: Similarity Content Declaration with Existing Course

S.N	Course Code	Similarity Content	Approx. % of Content
1.	MA522	solution of linear PDEs	15%
2.	MA512	Spaces and subspaces, transformations and change of basis, eigenvalues and eigenvectors,	10%
3.	MA524, EE534	Probability, Random Variables, Discrete and Continuous Probability Distributions	10%

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

The cumulative similarity content is more than 30%, which is expected for a course on mathematical techniques. Various postgraduate mathematics courses overlap with this course, however, the overlap does not exceed 10% with any one course. The present course is proposed as a core course in Fluid and Thermal Engineering (FTE) MTech program to develop a strong background in analytical techniques that are required in the various other

core and elective courses in the program and it cannot be therefore replaced by multiple mathematics courses. Moreover, there are topics which are not covered in any course available at IIT Mandi presently.

Other Faculty interested in teaching this course: P. Anil Kishan, Gaurav Bhutani

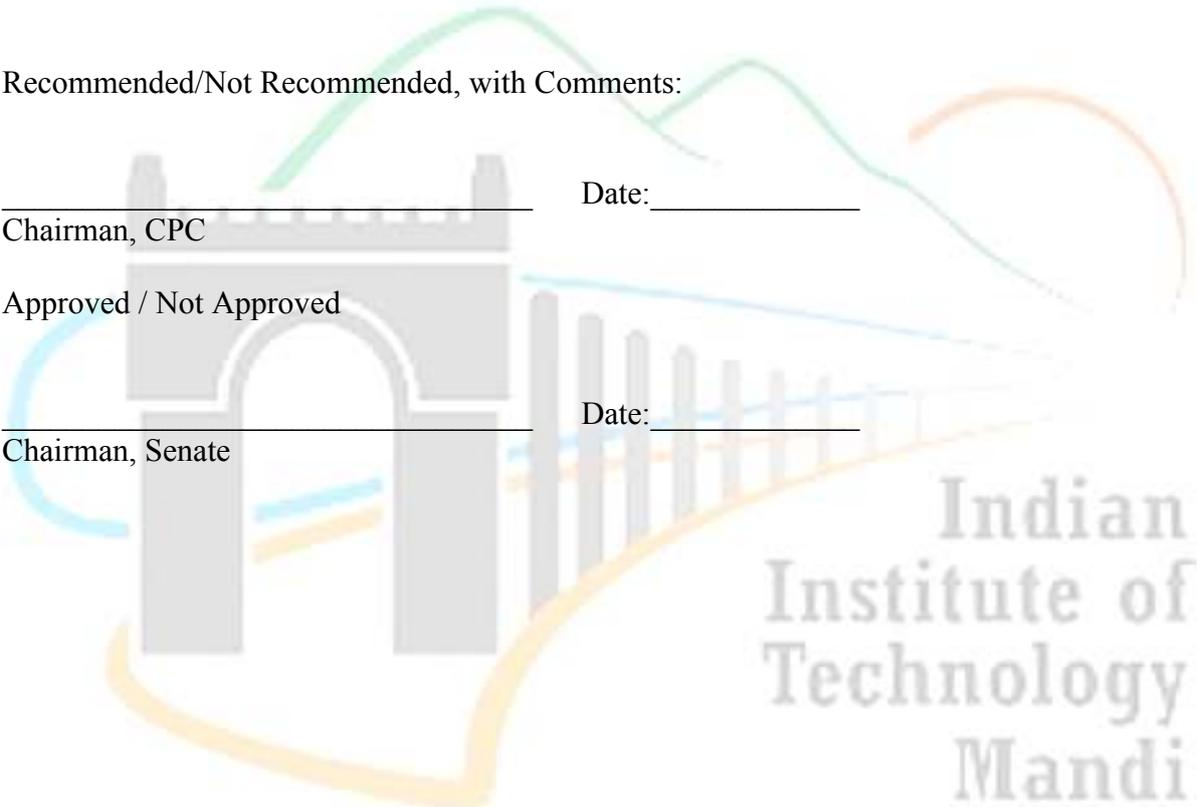Proposed by: Pradeep Kumar School: School of Engineering

Signature_____Date_____

Recommended/Not Recommended, with Comments:

_____   Date:_____
Chairman, CPC

Approved / Not Approved

_____   Date:_____
Chairman, Senate

Proposal for a New Course

IIT Mandi
Proposal for a New Course

Course Number : ME518
Course Name : Conduction and Radiation
Credits : 3-0-0-3
Prerequisites : None
Intended for : MTech/MS/PhD in engineering streams.
Distribution : Elective
Semester : Odd/Even

1: Preamble: The concepts involved in all three modes of heat transfer are beyond to deliberate in a single course of heat transfer even at the UG level. Thus, generally, the teaching of the concepts in heat transfer have been bifurcated into two parts and grouped conduction and radiation modes of heat transfer in one course, and convective mode of heat transfer in another course. Thus, this course covers the detailed topics in conduction and radiation modes of heat transfer.

2: Course modules with quantitative lecture hours:

- Derivation of Heat Conduction Equation for Heterogeneous, Isotropic Materials in Cartesian Coordinates. Heat conduction equation for homogeneous, isotropic materials in Cartesian, Cylindrical and Spherical Coordinates. Heat transfer from a fin of uniform and variable cross-section. Two-dimensional Steady State Heat Conduction: Solution by Method of Separation of Variables, time constants, thermal boundary layer, Steady 2D Conduction in Cylindrical Coordinates - Fourier-Bessel Series Solution.   [8hrs]
- Treatment of variable conductivity by Kirchhoff transformation.Unsteady State Conduction: Applications. Biot Number and its Physical Significance. Lumped System Analysis: Time Constant and its Physical Significance. Semi-Infinite Solid: Definition. Solution by Laplace Transform and Similarity technique. Time-dependent Boundary Conditions-Duhamel's Superposition Principle. Derivation of the integral. Solidification and Melting: Introduction. Stefan problem, enthalpy method. [8hrs]
- Inverse heat conduction and microscale transport: Determination of unknown boundary conditions from interior measurement; Stefan problem, enthalpy method, Experimental determination of thermal conductivity and heat capacity. Microscale heat transfer: hyperbolic heat conduction, speed of propagation of thermal waves, time lag, solution for a thin slab.   [6hrs]
- Introduction To Radiation heat transfer. Physical Mechanism. Laws of Thermal Radiation: Planck's Law. Wien's Displacement Law. Stefan-Boltzmann Law. Intensity of Radiation. Diffuse and Specular Surfaces. Absorptivity, Reflectivity and

Transmissivity. Monochromatic and Total Emissivity. Definition of an ideal gray body. Monochromatic and Total Absorptivity. Kirchhoff's Law. Restrictions of Kirchhoff's law. View Factor. Hottel's Crossed-strings Method:. Radiation Exchange in a Gray Enclosure. [5hrs]

- Two-Surface Enclosure: Network, Expression for the net radiation exchange. Radiation Shields. Radiation Effects in Temperature Measurement (Conduction effects negligible). Integral equation approach. Spectrally diffuse enclosure surfaces; band approximation. Treatment of specularly reflecting surfaces; specular and diffuse reflectivities, modified definition of radiosity, method of images. [5hrs]
- The equation of radiative heat transfer in participating media. Solution methods. Non-Gray Radiative properties of molecular gases. Introduction to HITEMP DATABASE. Approximate solution methods for one-dimensional media: The optically thin approximation. The optically thick approximation (Diffusion Approximation). [5hrs]
- Gas Radiation: Introduction. Beer's law: Monochromatic transmissivity, absorptivity and emissivity of a gas. Mean Beam Length. Gas emissivity charts. Correction factor charts. Heat Exchange between gas volume and black enclosure: Calculation of gas absorptivity using charts. Heat exchange between two black parallel plates at different temperatures. Heat exchange between gas volume and gray enclosure: Hottel's Expression. [5hrs]

3. Text Books
1. Hahn, D. W., and Ozisik, M. N., Heat Conduction, John Wiley and Sons, 2012.
2. Modest, M.F., Radiative Heat Transfer, 3rd Edition Academic Press, 2013.

4. Reference
1. Arpaci, V. S., Conduction Heat Transfer, Longman Higher Education 1967.
2. Siegel, R., and Howell, J., Thermal Radiation Heat Transfer, Taylor and Francis, 2015.
3. Schneider, P., Conduction Heat Transfer, Addison-Wesley Pub. Co, 1974.
4. Kakac et al., Heat Conduction, CRC Press, 5st ed, 2018.
5. Myers, Analytical Methods in Heat Conduction, AMCH, 2nd Ed 1998.

5: Similarity Content Declaration with Existing Course

S.N	Course Code	Similarity Content	Approx. % of Content
1	ME613	Radiation properties of real surfaces, Methods to calculate view factor, The equation of radiative heat transfer in participating media. Solution methods	20-25%

Justification for new course proposal if cumulative similarity content is > 30 %

Not Applicable

Proposal for a New Course

Other Faculty interested in teaching this course: P. Anil Kishan, Gaurav Bhutani

Proposed by: Pradeep Kumar School: School of Engineering

Signature_____Date_____

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Chairman, CPC

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Chairman, Senate

Proposal for a New Course