INDIAN INSTITUTE OF TECHNOLOGY MANDI

KAMAND, DISTT. MANDI – 175075 (HIMACHAL PRADESH)

MINUTES OF 38TH BOARD OF ACADEMICS MEETING

VENUE : A-4(SC) and GUEST HOUSE (NC) CONFERENCE ROOM, KAMAND

DATE : 22ND JANUARY, 2021 (FRIDAY)

TIME : 03:00 P.M.

Following members attended the meeting

Sl. No	Responsibilities	Name
1	Dean Academics	Dr. Pradeep Parameswaran
2	Associate Dean (Research)	Dr. Rahul Vaish
3	Associate Dean (Courses)	Dr. Anil K Sao
4	Chairman Library Advisory Committee	Dr. Astrid Kiehn
5	Chairman Course Proposal Committee	Dr. Kunal Ghosh
6	Course Coordinator (IC Courses)	Dr. Aniruddha Chakraborty
7	Course Coordinator (HSS Courses)	Dr. Suman Sigroha
8	Course Coordinator (B.Tech.-CSE)	Dr. Dileep A D
9	Course Coordinator (B.Tech.-EE)	Dr. Rahul Shrestha
10	Course Coordinator (B.Tech.-ME)	Dr. Gaurav Bhutani
11	Course Coordinator (B.Tech.-DSE)	Dr. Manoj Thakur
12	Course Coordinator (B.Tech.-EP)	Dr. Pradeep Kumar (SBS)
13	Course Coordinator (B.Tech.-M.Tech. Integrated Dual Degree in Bio-Engg.)	Dr. Shubhajit Roy Chowdhury
14	Course Coordinator (M.Tech.-(Mechanical Engg. (Energy Systems))	Dr. Pradeep Kumar
15	Course Coordinator (M.Tech.- (Energy Engg. (Materials))	Dr. Sumit Sinha Ray
16	Course Coordinator (M.Tech.-(Structural Engg.))	Dr. Sandip Kumar Saha
17	Course Coordinator (M.Tech.-(VLSI))	Dr. Hitesh Shrimali
18	Course Coordinator (M.Tech.-(Communication and Signal Processing))	Dr. Siddartha Sarma
19	Course Coordinator (M.Tech.-(Power Electronics and Drives))	Dr. Narsa Reddy Tummuru
20	Course Coordinator (M.Tech.-Biotechnology)	Dr. Shyam K Masakapalli
21	Course Coordinator (MA Dev.Studies)	Dr. Shyamasree Dasgupta
22	Course Coordinator (M.Sc.-Physics) + (I-Ph.D. (Physics))	Dr. Ajay Soni
23	Nominee-1: School of Engineering	Dr. Gaurav Bhutani
24	Nominee-1: School of Computing & Electrical Engineering	Dr. Srikant Srinivasan
25	Nominee-2: School of Computing & Electrical Engineering	Dr. Manas Thakur
26	Nominee-1: School of Basic Sciences	Dr. Nitu Kumari
27	Nominee-2: School of Basic Sciences	Dr. C.S.Yadav
28	Nominee-1: School of Humanities & Social Sciences	Dr. Devika Sethi
29	Nominee-2: School of Humanities & Social Sciences	Dr. Puran Singh
30	Industry Member – 1	Dr. Nadeem Akhtar
31	Research Affairs Secretary	Mr. Pawan Kumar Mandal
32	Academic Affairs Secretary	Mr. Arnav Prasad
33	Assistant Registrar (Academics): Secretary	Mr. Vivek Tiwari

Following members could not attend the meeting

Sl. No.		Name	
1	Course Coordinator (B.Tech.-CE)	Dr. Maheshreddy Gade	Member
2	Course Coordinator M.Sc. (Chemistry)	Dr. Chayan K Nandi	Member
3	Course Coordinator (M.Sc.-Applied Maths)	Dr. Rajendra K Ray	Member
4	Nominee-2: School of Engineering	Dr. Subhamoy Sen	Member

Special Invitee

Sl. No.	Name	
1.	Dr. Sunny Zafar	Asst. Prof., SE
2.	Dr. Srikanth Sugavanam	Asst. Prof., SCEE
3.	Dr. Erwin Fuhrer	Visiting Asst. Prof., SCEE
4.	Dr. Rajesh Ghosh	Asst. Prof., SE
5.	Dr. Sayantan Sarkar	Asst. Prof., SE
6.	Dr. Tulika P Srivastava	Assoc. Prof., SBS

PART-A

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

38.1 Confirmation of the minutes of 37th meeting of Board of Academics:

The minutes of the 37th Board of Academics meeting held on 29th October, 2020 were confirmed.

38.2 To consider the revised proposal for Independent Study Course:

The Board of Academics deliberated on the revised proposal for Independent Study Course presented by Dr. Sandip Saha, Coordinator for Independent Study Course proposal committee. Board of Academics deferred the proposal and gave inputs for modification of the proposal.

38.3 To consider the proposal for Semester Internship in B.Tech. program:

Dr. Sunny Zafar, Advisor of Career and Placement Cell presented a proposal to the Board of Academics for Semester Internship in B.Tech. program. After due deliberations, the BoA recommended the proposal with minor changes for consideration of the Senate and its approval. The final modified proposal is placed as **Annexure-A**.

38.4 To consider the proposal for revision of M.Tech. program in Mechanical Engineering with Specialization in Energy System by a new name Fluid and Thermal Science:

Dr. Pradeep Kumar, Course Coordinator for M.Tech. in MES branch presented a proposal to the Board of Academics regarding modification in the course structure of M.Tech. program in Mechanical Engineering with Specialization in Energy System program. After due deliberations, the BoA recommended the proposal with minor changes for consideration of the Senate and its approval. The final modified proposal is placed as **Annexure-B**.

38.5 To consider the proposal for revision of M.Tech. program in Energy Engineering with Specialization in Materials (EEM) to M.Tech. in Materials and Energy Engineering:

Dr. Sumit Sinha Ray, Course Coordinator for M.Tech. in EEM branch presented a proposal to the Board of Academics regarding revision of M.Tech. program in Energy Engineering with Specialization in Materials to M.Tech. in Materials and Energy Engineering. After due deliberations, the BoA recommended the proposal with minor changes for consideration of the Senate and its approval. The final modified proposal is placed as **Annexure-C**.

38.6 To consider the proposal to start a new programme i.e. M.Tech. in Computer Science and Engineering (CSE):

Dr. Manas Thakur, nominee SCEE, presented a proposal to the Board of Academics for starting a new programme i.e., M.Tech. in Computer Science and Engineering (CSE). After due deliberations, the BoA recommended the proposal with minor changes for consideration of the Senate and its approval. The final modified proposal is placed as **Annexure-D.**

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

The Chairperson, Course Proposal Committee (CPC) presented eight courses for consideration and approval of the BoA. After due deliberations, the BoA recommended seven courses with minor modifications for consideration of the Senate and its approval, which is placed as **Annexure - E**:

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	Basic 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

The following course was deferred by the BoA:

Sl.No.	Course No.	Course Title	Credits (L-T-P-C)
1	BE 3XX	Bioelectrical Systems Modeling	3-0-2-4

38.8 Any other item with the permission of the Chair.

-NIL-

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

7/12/2021

Secretary, Board of Academics

12/3/2021

Chairman, Board of Academics

PART-B

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

-NIL-

ANNEXURE-A

Semester Internship Proposal
IIT Mandi

1 Preamble

The Institute as a part of its mission wants to provide opportunities to work intensely with industry in pursuit of the above goals of education and research, leading to the development of cutting edge and commercially-viable technologies. Many companies that offer internships in core branch profiles require an internship having a semester-long duration. This proposal has been created to tap these opportunities. This will enable the undergraduate B.Tech. students and B.Tech.
+ M.Tech. (Integrated Dual Degree) students to do a semester-long internship in the industry and gain industrial experience. The learning outcome derived from semester-long internship is expected to be far greater than those provided by other shorter duration internships. Hence, this proposal opens up opportunities for students to work intensely with the industry to pursue IIT Mandi's goals of education and research and is thereby aligned with the vision of IIT Mandi.

2 Background

In the 37th Board of Academics (BoA) meeting, a committee was formed on the recommendation of the Chair, Prof. Pradeep C. Parameswaran which included the following members:

1. Dr. Sunny Zafar (Chair), Advisor (CnP Cell)
2. Dr. Kunal Ghosh
3. Dr. Varun Dutt
4. Student Academic Affairs Secretary, Mr. Arnav Prasad

The BoA subcommittee was assigned the responsibility of formulating a proposal, to make provisions for semester internship (formerly known as "6-month internship") at IIT Mandi. After 2 formal meetings (on 11 November 2020 and 24 December 2020) and detailed deliberations, the committee successfully formulated a proposal.

3 Recommendations of the committee

The provision of semester internship shall be applicable with effect from the **undergraduate batch admitted in 2018**.

3.1 Valid semesters to go on a semester internship

- B.Tech. students will be allowed to go on a semester internship after the completion of 5^{th} semester (excluding the final semester).
- B.Tech. + M.Tech. (Integrated Dual Degree) students will be allowed to go on a semester internship after the completion of 6^{th} semester (excluding the final semester).

3.2 Prerequisites

A student will require the approval of the Faculty Advisor and the Advisor (CnP Cell), along with permission from the Associate Dean (Courses) to go on a semesterinternship.

Note: The students should give the Faculty Advisor, Advisor (CnP Cell), Associate Dean (Courses) and Academic section adequate time to process their application request.

3.3 Course and Credit distribution

- A "Semester Internship" course of 9 credits shall be introduced.
- The distribution of these 9 credits (to Discipline Elective and Free Elective baskets) will be as per the distribution mentioned in the course proposal document for Semester Internship.

3.4 Accommodating a semester internship without having to opt for a semester break

- If a student holds a semester internship offer, he/she may be allowed to do at most 9 credits of Pass/Fail in one semester (hence relaxing the previously 6 Pass/Fail credits-per-semester limit).
- 2 credits from "Industrial Internship" + 9 credits from "Semester Internship" results in 11 credits in a semester.
- For any particular semester in which a student is doing their semester internship, the minimum 12 credits-per-semester limit may be relaxed to 11 credits. Hence, this semester shall be treated as a regular semester.
- Applicable fee for the semester must be paid.

3.5 Evaluation

A report (ideally 4 pages, in standard format) on the work done during internship should be submitted by the student to their Faculty Advisor. Additionally, any further requirement if deemed necessary by the Faculty Advisor may be included in the evaluation pattern. The evaluation outcomes can be either Satisfactory (P grade) or Unsatisfactory (F grade).

3.6 Important Note

Ideally, all students are expected to complete their semester internship. Dropping the semester internship is highly discouraged and would only be allowed in very exceptional circumstances at the discretion of the Faculty Advisor and Advisor (CnP Cell), for which the barrier would be high. No “Industrial Internship” credits will be awarded for any partially completed internship.

IIT Mandi
Proposal for a New Course

Course Name: Semester Internship Course
Number : DP399P XX
Credits : 0-0-18-9
Prerequisites : Consent of the Advisor (CnP Cell), Faculty Advisor and Associate Dean (Courses).
Intended for : B.Tech. and B.Tech. + M.Tech. (Integrated Dual Degree)
Elective or Compulsory : Elective
Semester : After the completion of 5^{th} semester (excluding the final semester) for B.Tech. and after the completion of 6^{th} semester (excluding the final semester) for B.Tech. + M.Tech. (Integrated Dual Degree).

Preamble

Many companies that offer internships in core branch profiles require an internship having a semester-long duration. This course is proposed to tap these opportunities. This course is offered to the undergraduate B.Tech. students (after the completion of 5^{th} semester, excluding the last semester) and B.Tech. + M.Tech. (Integrated Dual Degree) students (after the completion of 6^{th} semester, excluding the last semester) to enable them to do a semester-long internship in industry and gain industrial experience. The learning outcome derived from this semester-long internship is expected to be far greater than those provided by other shorter duration internships. This course opens up opportunities for students to work intensely with the industry to pursue IIT Mandi's goals of education and research, leading to the development of cutting edge and commercially-viable technologies and is thereby aligned with the vision of IIT Mandi.

Evaluation

A report (ideally 4 pages, in standard format) on the work done during internship should be submitted by the student to their Faculty Advisor. Additionally, any further requirement if deemed necessary by the Faculty Advisor may be included in the evaluation pattern. The evaluation outcomes can be either Satisfactory (P grade) or Unsatisfactory (F grade).

Distribution of credits to baskets

The distribution of the aforementioned 9 credits shall be as follows:

- For students pursuing Honours program: 6 credits to the Discipline Elective basket and 3 credits to the Free Elective basket.
- For other students: 3 credits to the Discipline Elective basket and 6 credits to the Free Elective basket.

Important Note

The students should give the Advisor (CnP Cell), Faculty Advisor, Associate Dean (Courses) and Academic section adequate time to process their application request. It is important to note that dropping this course is highly discouraged and would only be allowed in very exceptional circumstances at the discretion of the Faculty Advisor and Advisor (CnP Cell), for which the barrier would be high.

Proposal

for

Major Revision/Replacement of M. Tech. Program

in

Mechanical Engineering with Specialization in Energy Systems

With

M. Tech. in Fluid and Thermal Engineering (FTE)

School of Engineering,

Indian Institute of Technology Mandi,

Mandi, Himachal Pradesh, 175075, India

1. Background and Justification for Major Modification:

The existing M.Tech. (MES) program was developed with a futuristic view of training students for the entire energy sector. Over the years it is realized that the curriculum is broad and more focus to ensure the specialization with expertise in certain conventional domains (convention followed in companies and other institutions for recognizing skill sets) are needed. It is also difficult to train a student in a M.Tech program on such a broad scope topic without developing a strong platform in a specified domain.

The M.Tech (MES) program attempted to cover the bottom three steps of the energy pyramid (Appendix-1) with more information based courses. Other subjects like, law, policy, economics, renewable sources etc. were also introduced. In order to improve the content and provide specialized training on conventional subjects such as fluid and thermal engineering, we propose a major modification to the M.Tech. MES. To strengthen the program and also make it relevant for industry, we contacted academicians, industry and incorporated the received feedback. Based on the past 5 years of teaching-learning experiences from faculty members, students and received feedback from other IITs and industry representatives in combination with the placement scenario, it is proposed that the major modifications in the M.Tech (MES) program is necessary. We have followed the process laid by IIT Mandi to propose or revise of a program. The feedback from Academic and Industry experts have been sought and detailed surveys of similar programs in first and second generation IITs have been conducted.

2. Key features of modified M.Tech. Program:

Some of the benefits of proposed M.Tech. in fluid and thermal engineering are highlighted below:

1. Provides specialization in conventional domain of fluid and thermal engineering with emphasis on energy applications.
2. Offers both theoretical and laboratory courses in cohesive manners to enable deeper understanding of thermal engineering.
3. Promotes skill developments in advanced analytical techniques, computational fluid dynamics (CFD) and experimental methods in thermal engineering.
4. Flexible structure of this program enables the students to develop strong foundation in any energy sectors such as solar, wind, thermal, geothermal, battery and any other emerging field in future through electives.

3. Program Structure and Details

3.1. Who Should Apply?

The applicant must have a Bachelor's degree in Mechanical, Aerospace, Chemical and related engineering branches along with GATE qualification (exemption allowed to IIT graduates as per institute norms).

3.2. Annual Intake: As per the need and institute guidelines.

3.3 Program Structure - Total Credit - 71 and distribution of these credits are as follows.

Type of Courses	Maximum Credit
Discipline Core courses	16
Discipline Elective Courses	12
Outside Discipline Elective courses/ Open Elective Courses	6
Practicum & Technical Communication	5
Thesis	32
Total	71

3.4 Semester-wise distribution of courses

3.4.1 First Semester (Credits- 16)

S. No	Subject Type	Subject Code	Subject Name	L-T-P-Cr	Status
1	Core	ME603	Advanced Fluid Mechanics	3-0-0-3	Approved in 2nd senate
2	Core	ME517	Advanced Analytical Techniques for Engineers	3-1-0-4	Prepared
3	Core	ME615	Applied Computational Fluid Dynamics	3-0-0-3	Approved in 3rd senate
4	DE		Discipline Elective -1	3-0-0-3	
5	DE		Discipline Elective -2	3-0-0-3	

3.4.2 Winter Break (Credits -3)

S. No	Subject Type	Subject Code	Subject Name	L-T-P-Cr	Status
1	Practicum	ME501P	Practicum -I	0-0-6-3	Prepared

3.4.3 Second Semester (Credits – 20/19)

S. No	Subject Type	Subject Code	Subject Name	L-T-P-Cr	Status
1	Core	ME 616	Convective Heat and Mass Transfer	3-0-0-3	Approved in 9th senate
2	Core	ME604	Experimental Methods in Thermal Engineering	3-0-0-3	Approved in 2nd senate
3	Discipline Elective		Discipline Elective-3	3-0-0-3	
4	Discipline Elective		Discipline Elective-4	3-0-0-3	
5	ODE		Outside Disciple Elective - 1	3-0-0-3	
6	ODE		Outside Disciple Elective - 2	3-0-0-3	
7#	Core	ME519	Technical Communication	0-2-0-2	Prepared
7#	Core	HS541	Technical Communication	1-0-0-1	Approved

#Students may choose one of the offered Technical Communication courses (ME519 or HS541)

3.4.4 Third Semester (Credits -16)

S. No	Subject Type	Subject Code	Subject Name	L-T-P-Cr	Status
1	Thesis	ME598P	PGP-I	16	

3.4.5 Fourth Semester (Credits-16)

S. No	Subject Type	Subject Code	Subject Name	L-T-P-Cr	Status
1	Thesis	ME599P	PGP-II	16	

3.5 List of Discipline Electives*:

S. No	Subject Code	Status	Subject Name
1	ME 613	Approved in 9th Senate	Thermal Radiation
2	ME 601	Approved in 2nd Senate	Advanced Finite Element Methods
3	ME 614	Approved in 3rd Senate	Compressible Flow and Gas Dynamics
4	ME 625	Approved in 9th Senate	Introduction to Turbulence and its

			modelling
5	ME 636	Approved in 10th Senate	Combustion Technology
6	ME518	Prepared	Conduction and Radiation
7	ME504	Approved in 10th Senate	Numerical Methods for Engineering Computation
8	ME605	Approved in 2th Senate	Airconditioning and Ventilation
9	ME621	Approved in 6th Senate	Aircraft Propulsion
10	ME610	Approved in 2nd Senate	Advanced Thermodynamics
11	ME 505	Approved in 9th Senate	Applied Finite Element Method
12	ME 507	Approved in 9th Senate	Micro and Nanoscale Fluid Mechanics
13	ME513	Approved in 24th Senate	Finite Element Methods in Engineering
14	ME 611	Approved in 2nd Senate	Design and Optimization of Thermal Systems
15	ME 631	Approved in 10th Senate	Heat Transfer and Fluid flow in Energy Systems

*This list will be further updated with the inclusion of new senate approved courses on the recommendation of program faculty group (PFG).

Appendix-1 : Illustration of interaction of engineering streams in the electricity generation process

For example, the electricity generation process and involved conventional engineering streams in this process can be understood from the following energy pyramid. The proposed M.Tech program in fluid and thermal engineering forms the strong foundation for the energy sector.

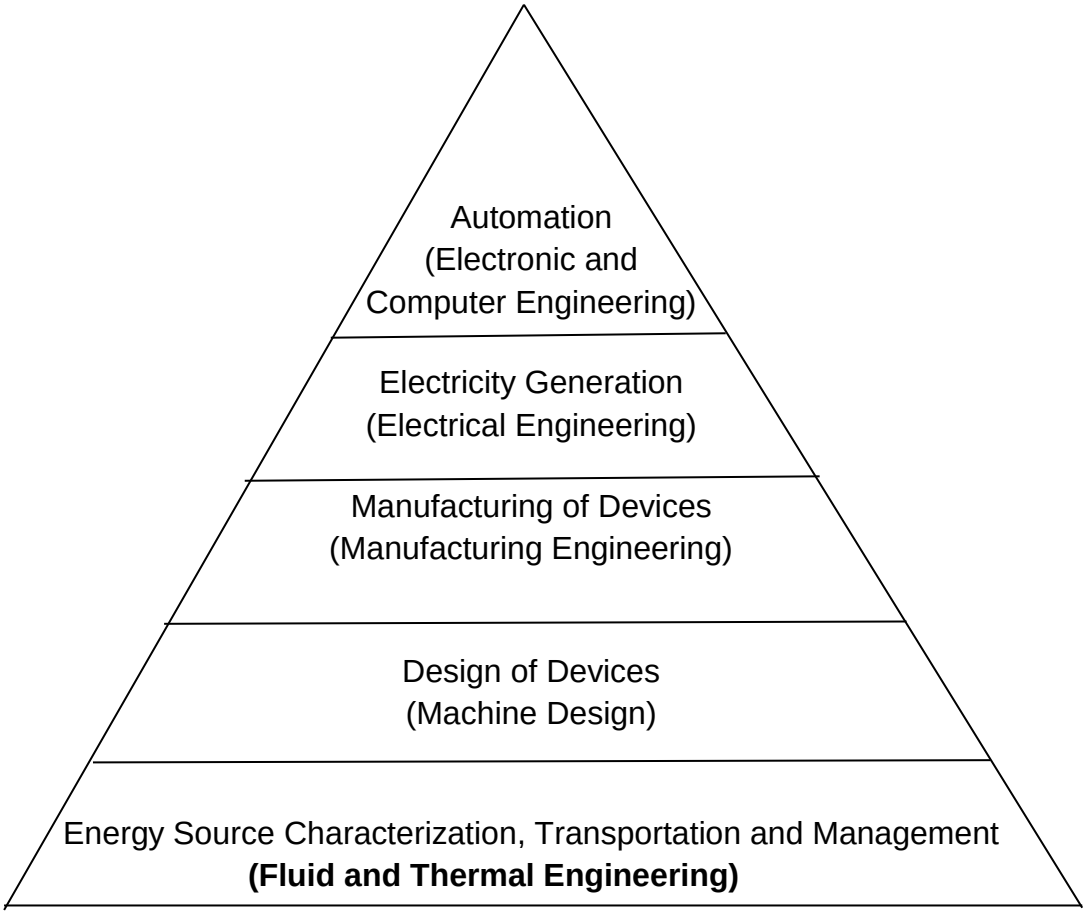

Figure 1: Energy Pyramid involving Engineering Streams.

ANNEXURE-C

Proposal

for

Major Revision/Replacement of M. Tech. Program

in

Energy Engineering with Specialization in Materials

by

Materials and Energy Engineering (MEE)

School of Engineering

Indian Institute of Technology Mandi

Mandi, Himachal Pradesh, 175075, India

What the new program can offer

With ever increasing energy requirement and clear ill-effects of our dependence on fossil-fuel on the climate, impact of well-established studies on energy management is undeniable; especially the non-conventional energy sector and material development for such or existing energy systems are of national and international importance. Amongst others, a major emphasis is bestowed upon novel material synthesis and their application in renewable/non-conventional energy conversion and storage on a global scale. Over recent years there has been a steady growth in the renewable energy sector, which is vastly driven by boost of research in novel material incorporation in existing systems. The recent changes in government policies favoring non-conventional/renewable energy sectors, focused research on development of 'energy materials'/ efficient systems have clear implication on increased demand for specialists and engineers in this evolving scenario, both understanding the science and technology of material development followed by system improvement and its management for allied policy regulation. This program intends to fill the void between the two with a holistic approach of course curriculum consisting of deep understanding of the present infrastructure, policies, scope of improvement and development of new materials/technology useful for both conventional and non-conventional energy systems. Hence, *M Tech MEE* aims to train students who can walk both the shoes of an energy engineer/technologist and policy regulator with strong expertise on materials.

Description of the program

The proposed revision to EEM is an amalgamation of conventional and non-conventional energy related courses focusing on emerging energy source and economical aspects, basics of materials for energy engineering with focus towards renewable energy related studies, computational methodologies etc. The course curriculum consists of one-year course work followed by a one year of post-graduation project work. This curriculum envisages to prepare the students for a professional or research career either in industries or academia after the completion of the program.

Features of this program

- Courses with in-depth understanding of Materials for Energy Engineering along with hands-on experimental facilities
- Detailed materials characterization-based laboratory experiments with support from Advanced Materials Research Laboratory at IIT Mandi

- ❖ Computational methods-oriented laboratory course which is a must for modern material engineers
- ❖ Vast choice of discipline electives to be chosen from pool of courses of IIT Mandi pertaining to Energy Engineering
- ❖ Scope of focused research on materials-energy-materials for energy nexus

Apart from these, a few added benefits of this revision may not be ignored, albeit they do not strictly contribute to the main harvests of revised curriculum -

- More useful courses for MS/PhD students who hail from the said area and envisage to research on same
- Possible rejuvenation in B Tech Minors in Materials.
- As pointed out by the external review committee, program on materials area may take advantage of excellent research facilities at IIT Mandi in the area of Materials and strengthen the academic activities further.

Program structure

Eligibility criteria:

The eligibility criteria of the said program are

a) B Tech in Mechanical, Metallurgical, Production, Manufacturing, Materials, Chemical and Electrical/relevant Engineering with Valid GATE score (GATE paper code EC: Electronics and Communication Engineering may not be allowed)
b) M Sc. Physics or Chemistry with Valid GATE Score.

* Engineering Stream who has chosen Engineering Science (XE) as GATE examination with only relevant paper codes (exam paper codes- D, G and H: Solid mechanics, food technology and atmospheric and ocean sciences are not allowed)

Annual Intake: As per the need and institute guidelines.

Credit distribution:

Total credits requirements: 72

Dissertation: 32 Credits

Course work: 39 Credits

Industrial training: 4-6 weeks (1 Credit)

Courses	Credits
Core courses (including Laboratory)	**23**
Discipline elective courses	**9**
Technical communication, Industrial visits/Research internship	**2**
Outside discipline elective courses	**6**
Final Year project	**32**

Proposed Curriculum

	Semester I				
	Course Name	**Credit Structure**			
		L	**T**	**P**	**C**
1.	C1: Emerging energy resources and economics *(proposed)*	3	0	0	3
2.	C2: Functional Materials for Energy Engineering *(modified)* (ME609)	3	0	0	3
3.	C3: Electrochemistry for Energy Engineering *(proposed)*	3	0	2	4
4.	L1: ***Structure-Property Correlations for Energy Applications*** *(modified)* (EN612)	1	0	4	3
5.	Discipline Elective-1	3	0	0	3
6.	Outside Discipline Elective-1	3	0	0	3
7.	Technical Communication	1	0	0	1
	Total				**20**

	WINTER BREAK				
	Course Name	**Credit Structure**			
		L	**T**	**P**	**C**
8.	ME695P: PGP I *(proposed)*	0	0	2	**1**

	Semester II	
	Course Name	**Credit Structure**

		L	T	P	C
9.	C4: Photovoltaic Materials and Fabrication (EM 651)	3	0	0	3
10.	C5: Computational Methods in Material Science *(proposed)*	1	0	6	4
11.	C6: Durability Behaviour of Energy Materials *(modified)* (EN611)	3	0	0	3
12.	Discipline Elective-2	3	0	0	3
13.	Discipline Elective-3	3	0	0	3
14.	Outside Discipline Elective-2	3	0	0	3
15.	Industrial/Research Internship **(SUMMER TERM)**				1
	Total				**20**

	Semester III				
	Course Name	**Credit Structure**			
		L	**T**	**P**	**C**
16.	ME696P: PGP II	0	0	30	**15**

	Semester IV				
	Course Name	**Credit Structure**			
		L	**T**	**P**	**C**
17.	ME697P: PGPIII	0	0	32	**16**

List of possible discipline electives

1. Energy Storage Technology* (Approved in 9th Senate Meeting) (EN503)
2. Nanomanufacturing* (Approved in 8th Senate Meeting) (ME509)
3. Nano-electronics and nano-microfabrication*(Approved in 6th Senate Meeting) (EE615)
4. Carbon Materials and Technology* (ME 515)
5. Science and Technology of Nanomaterials*(Approved in 9th Senate Meeting) (CY554)
6. Hydrogen Generation and Storage*(Approved in 9th Senate Meeting) (CY552)
7. Convective Heat and Mass Transfer* (Approved in 9th Senate Meeting) (ME 616)
8. Heat Transfer and Fluid Flow in Energy Systems* (Approved in 10th Senate Meeting) (ME 631)
9. Introduction to High Voltage Engineering and Dielectric Breakdown* (Approved in 5th Senate Meeting) (EE 606)
10. Materials Processing Technology
11. Energy Materials and Devices
12. Materials Recycling and Waste Management

13. Power sources for electric vehicles
14. Fuel Cell Technology
15. Energy storage systems coupled with Microgrids

* Courses which are already running at IIT Mandi

Rationale behind the modification

The core of Energy Engineering is largely intertwined with the concepts of Material Science and the engineering thereof. To produce a successful manpower in the area of Energy Engineering with in-depth knowledge of Materials, one must appreciate the intricacies of materials' roles eventually. During the past 5 years, faculty members associated with teaching and most importantly, the students could feel that the existing curriculum is broad and do not provide sufficient in-depth understanding of certain core subjects and lacks the needed specialization at master level. Several internal meetings with students allowed the concerned faculty members to introspect the curriculum. Apart from missing the specialization of this program, the confusion among recruiters with the program name and many information based courses were other concerns. In addition, higher studies opportunities are also limited to specific places/departments where energy engineering degree is recognized while such opportunities in materials area are significantly high.

To improve this program, internal meetings between faculty members of School of Engineering took place thrice- dated- 03.07/07.08/ and 03.09.2020, followed by in-depth discussion with PFG-EEM on 16.11.2020. The feedbacks from students were collected over a significant period. The industrial expert review was conducted by 02.12.2020. Finally, the proposal was placed before Board of Academics on 22.01.2021 for further discussion.

Annexure I : Previous Curriculum

	Semester I				
	Course Name	**Credit Structure**			
		L	**T**	**P**	**C**
1.	F1. Foundation 1: EN501: Energy Sources and Power Plants	3	0	0	3
2.	F2. Foundation 2: EN502: Emerging Energy Sources	3	0	0	3
3.	F3. Foundation 3: HS 540: Energy: Environment Policy and Law	3	0	0	3
4.	C1. EN503: Energy Storage Technology	2	0	2	3
5.	EN505P: Energy Systems Laboratory	0	0	4	2

6.	DP500P: Research Practicum	0	0	6	3
7.	HS541: Technical Communication	1	0	0	1
8.	Free Elective-1	3	0	0	3

	Semester II				
	Course Name	**Credit Structure**			
		L	**T**	**P**	**C**
9.	C2. ME 620: Modelling and Simulation	2	0	2	3
10.	C3. EN611: Durability Behaviour of Energy Materials	3	0	0	3
11.	C4. EN612: Structure- Property correlation in materials for Energy Applications	3	0	0	3
12.	Specialization Elective-1	3	0	0	3
13.	Free Elective-1	3	0	0	3
14	Free Elective-2	3	0	0	3
	Summer Term				
15.	DP 512 P: Industrial/ Research Internship				1

	Semester III				
	Course Name	**Credit Structure**			
		L	**T**	**P**	**C**
16.	C5. EN613 Creep-Fatigue Interaction	3	0	0	3
17.	ME596P: Dissertation	0	0	28	14

	Semester IV				
	Course Name	**Credit Structure**			
		L	**T**	**P**	**C**
18.	ME597P: Dissertation	0	0	36	18

ANNEXURE D

Proposal for

Master of Technology

1. **Master of Technology in Computer Science and Engineering**
2. **Master of Technology in Computer Science and Engineering with Specialization in Systems Engineering**
3. **Master of Technology in Computer Science and Engineering with Specialization in Intelligent Systems**

School of Computing and Electrical Engineering,
Indian Institute of Technology Mandi,
Himachal Pradesh, India.

1. Name of the Degree Program

1. Master of Technology in Computer Science and Engineering
2. Master of Technology in Computer Science and Engineering with Specialization in Systems Engineering
3. Master of Technology in Computer Science and Engineering with Specialization in Intelligent Systems

2. Abbreviation

Master of Technology is abbreviated as M.Tech.

3. Duration

The duration of this program is two years. Each year consists of two semesters, summer and winter terms.

4. Credits to be Earned

The students have to earn a minimum of 70 credits for the degree of Master of Technology in Computer Science and Engineering, with or without the specializations. Credit distribution details are given under "Program Details".

5. Campus Stay

Students admitted to these degree programs are required to stay on campus and to participate and complete all requirements of the program, except for the exploratory work during winter vacation as described in Section 4 under "Program Details".

All other details are in accordance with the ordinance and regulations for M.Tech/M.Sc of IIT Mandi (see http://iitmandi.ac.in/academics/files/Ordinances-for-M.Tech-M.Sc.pdf).

Program Details

1. Preamble to the Program

Over the last two decades, the discipline of computer science and engineering (CSE) has grown enormously. CSE is now a bridge discipline that enables working in other scientific disciplines as well. Although a four-year BTech curriculum introduces a student to the various facets, it is imperative that the student be trained in the advanced developments in certain areas and be practically familiar with various applications of the same in industry and research.

The two-year MTech program in Computer Science and Engineering at the Indian Institute of Technology Mandi is proposed to (a) teach the theory and practice behind certain core as well as advanced areas, in the form of courses and labs; (b) impart the ability to work on and take ahead large applications in industry and research, in the form of a project; (c) give them an exposure to other disciplines in the form of elective courses

The degree would be awarded upon successful completion of the credit requirements for the course work and satisfactory performance in a (year-long) project. The minimum CGPA requirement would be as per the prevailing norms of the institute.

2. Program Objectives

- To equip students with a good understanding of the basics and the latest developments in computer science and engineering for a successful career in academia or industry.
- To produce technically well-rounded professionals to cater to the growing demand for such professionals for research and development in various areas of computer science and engineering.

3. Specializations Offered

- Systems Engineering
- Intelligent Systems

4. Credit Structure

- The minimum number of overall credits required to be completed is 70, out of which 41 credits will be fulfilled using course work, 3 credits using exploratory work during winter, and 26 credits using the postgraduate project (PGP).
- The course work would be divided into three categories: (i) core courses (11 credits) from a basket of suggested courses that each student is expected to complete; (ii) discipline electives (20 credits) that need to be taken from the relevant PG level courses (as listed in Section 5); and (iii) outside discipline electives (9 credits) that can be taken from any school of the institute. An overview of the proposed core courses is given in Section 4.
- 3 credits of exploratory work during winter break would be graded in a Pass/Fail manner. For this, the student can either work with a faculty member of the institute,

or go for an internship at an industry or another reputed academic institution. In case of an internship, the student will not be paid fellowship for the duration of the winter break.

- The postgraduate project starts from the summer following the first year and extends to the third and fourth semesters. The student would be allotted a guide to work on the PGP before the beginning of the third semester. There will be a committee to monitor the progress of the student in the project each semester and accord a grade for the project.
- **Specialization.** Students pursuing at least 12 discipline elective credits in a specific stream (systems engineering or intelligent systems) with a C grade or above and whose PGP is in the same area would be eligible to get a specialization in the stream. Students who meet the above requirement could get an M. Tech. in Computer Science and Engineering with an option for specialization in systems engineering or intelligent systems (based upon the requirements listed above). If a student does not meet the above mentioned requirements for a specialization, then the student would graduate with a general M. Tech. in Computer Science and Engineering degree.

To summarize:

S. No.	**Category**	**Credits**
1.	Core courses	11
2.	Discipline electives (DE)	20
3.	Outside discipline electives (ODE)	9
4.	Exploratory work (EW)	3
5.	Postgraduate project (PGP)	26
6.	Technical Communication	1

Total credits per semester: 16-20

Year 1, Semester 1

S.No.	**Subject**	**Credits**	**Remarks**
1	Discrete Mathematics **OR** Linear Algebra AND Probability and Statistics	4	Core: The first option is recommended for a specialization in Systems Engineering and the second for a specialization in Intelligent Systems. Also, in the second option, two 2-credit courses will be offered in the first and the second halves of the semester.
2	Advanced CS Practicum	3	Core

3	Advanced Data Structures and Algorithms	4	Core
4	Electives	5 - 7	DE / ODE

Total Credits: 16 - 18

Year 1, Semester 2

S.no.	Subject	Credits	Remarks
1	Electives	16 - 20	DE / ODE

Total Credits: 16 - 20

Year 2, Semester 3

S.no.	Subject	Credits	Remarks
1	PGP	12	
2	Electives	4-8	DE / ODE

Total credits: 16 - 20

Year 2, Semester 4

S.no.	Subject	Credits	Remarks
1	PGP	14	2 credits are reserved for the thesis report.
2	Electives	Remaining credits	DE / ODE

Total credits: 16 - 20

5. Overview of Core Courses

Core 1a: Discrete Mathematics (DM; 4 credits)
Logic. Infinite and structured sets. Combinatorics and counting. Graph theory: matching, coloring. Modern techniques: extremal, probabilistic, and linear algebraic methods.

Core 1b: Linear Algebra and Applications (LAA; 2 credits)
Background and review. Norms for vectors and matrices. Perturbation theory and eigenvalue problems. Matrix factorization and least square problems. Sparse matrices, their analysis, and algorithms. Different types of matrices, their properties, and applications.

Core 1c: Probability and Statistics (PS; 2 credits)
Sigma field. Random variables. Conditional distribution and expectations. Markov chains. Convergence of random variables. Concentration inequalities. Random vectors and random processes.

Core 2: Advanced Data Structures and Algorithms (ADSA; 4 credits)

Basic math concepts. Sorting and Selection. Priority queues. Graph Definitions and Elementary Algorithms. Graph Matching. Flow-Networks: Matrix Computations. All Pair Shortest Path and dynamic programming. Integer data type. String Matching. Linear Programming. Randomized and Streaming Algorithms. External Memory Algorithms and Cache oblivious algorithms. NP-completeness. Dealing with NP-hard problems. Approximation algorithms. Parameterized complexity.

Core 3: Advanced Computer Science Practicum (ACSP; 3 credits)
End-to-end system design that involves database backend with transactions, triggers, etc., and front-end web-based visualization; design of modules/device drivers in operating systems; network simulator; assignments on compilers, and architecture.

6. List of Discipline Electives in Specialization Areas

The courses currently available for crediting as discipline electives in the areas of specialization are listed below. The PFG may add more courses in the future.

Systems Engineering:

CS502	Compiler Design	3-0-2-4
CS507	Computer Architecture	3-0-2-4
CS508	Introduction to Heterogeneous Computing	2-0-0-2
CS547	Network Management Systems	3-0-0-3
CS548	Cloud Networking	3-0-0-3
CS545	Software Design Patterns	3-0-0-3
CS546	Design of Concurrent Software	3-0-0-3
CS549	Computer Network Analysis	3-0-0-3
CS550	Introduction to Computer Graphics and Geometric Design	3-0-2-4
CS561	Map Reduce and Big Data	3-0-0-3
CS611	Program Analysis	3-1-0-4
CSxxx	Information Security	3-0-0-3

CSxxx	Reactive Design Patterns	3-0-0-3
CSxxx	Distributed Systems: Theory and Practice	3-0-0-3
CSxxx	Advanced Databases	3-0-0-3

Intelligent Systems:

CS506	Cognitive Modeling	2-0-2-3
CS560	Text Retrieval and Mining	3-0-0-3
CS562	Artificial Intelligence	3-0-0-3
CS563	Scalable Data Science	3-1-0-4
CS606	Computational Modeling of Social Systems	3-0-0-3
CS609	Speech Processing	3-0-2-4
CS630	Speech Technology	3-0-0-3
CS660	Data Mining for Decision Making	4-0-0-4
CS661	Knowledge Representation and Reasoning	3-0-0-3
CS662	Mobile Virtual Reality and Artificial Intelligence	3-0-0-3
CS669	Pattern Recognition	3-1-0-4
CS671	Deep Learning and Applications	3-1-0-4
EE511	Computer Vision	3-0-2-4
EE608	Digital Image Processing	3-0-2-4

Outside Discipline Electives:

Any graduate-level non-CS course from the school or from other schools is acceptable as an outside discipline elective. The purpose of these credits is to allow students to explore and

enhance their knowledge and interest in various domains of engineering, sciences, or humanities.

7. Placements

Here is a non-exhaustive list of companies/government organisations that might be interested to hire the students graduating with an M.Tech. in CSE from IIT Mandi:

● Amazon ● Flipkart ● DRDO ● Siemens ● Facebook ● Google ● Microsoft ● AMD	● Infosys ● Vehant ● TCS ● Samsung ● IBM ● Intel ● Nvidia

8. Program Outcomes

After completion of the degree, the students will have:

- good understanding of the design challenges and implementation of scalable solutions.
- those opting for specialization will have sufficient knowledge and practical experience with the problems being faced, and the solutions being proposed therein, in their respective areas of specialization: systems engineering, or intelligent systems.
- adequate communication skills and experience of working as a team.
- be equipped with the necessary knowledge and skills to get placed in CS-related industries or enter into Ph.D. programs in computer science or research labs.

Annexure E

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.

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:

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

IIT Mandi
Proposal for a New Course

Course Name: Basic 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)

2. Bioinformatics Principles and Applications. Z. Ghosh and B. Mallick Oxford University Press.

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:

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.

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:

---------- **Date:** _____

Chairman, CPC

Approved/Not Approved

---------- **Date:** _____

Chairman, Senate

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]**
  - [CS231n, DL Stanford course] https://www.youtube.com/watch?v=vT1JzLTH4G4&list=PLC1qU-LWwrF64f4QKQT-Vg5Wr4qEE1Zxk
  - [CS224n, NLP Stanford course] https://www.youtube.com/watch?v=8rXD5-xhemo&list=PLoROMvodv4rOhcuXMZkNm7j3fVwBBY42z
  - [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 Aditya Nigam Date

Recommended/Not Recommended, with Comments:

_____ Date:_____

Chairman, CPC Approved / Not Approved

_____ Date:_____

Chairman, Senate

External Review by Dr. Chetan Arora, Associate Professor, CSE, IIT Delhi

1. Maybe you would like to change the topic to Selected Topics or Advance Topic in Deep Learning. This may give you the freedom to change or update the topics from year to year based upon the new developments in the area. Given the fast development in the area, this may be needed soon in the proposed course.

Agreed. I suggest to change its name as follows:

"CSXXX: Advance Topics in Deep Learning"

2. For demonstrating the whole gamut of generative models in deep learning, you also want to cover VAE and AR models along with GANs in the course.

VAE is already covered in CS671.

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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**

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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. Srikanth **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