INDIAN INSTITUTE OF TECHNOLOGY MANDI

KAMAND, DISTT. MANDI – 175075 (HIMACHAL PRADESH)

MINUTES OF 44TH BOARD OF ACADEMICS MEETING

VENUE	:	A-1 NKN (SC) and GUEST HOUSE (NC) CONFERENCE ROOM + ONLINE
DATE	:	24th NOVEMBER, 2021 (WEDNESDAY)
TIME	:	03:00 P.M.

Following members attended the meeting

Sl. No	Responsibilities	Name
1	Dean Academics	Prof. 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. Hitesh Shrimali
7	Course Coordinator (HSS Courses)	Dr. Rajeshwari Dutt
8	Course Coordinator (B.Tech.-CE)	Dr. Maheshreddy Gade
9	Course Coordinator (B.Tech.-CSE)	Dr. Jinesh Machchar
10	Course Coordinator (B.Tech.-ME)	Dr. Himanshu Pathak
11	Course Coordinator (B.Tech.-DSE)	Dr. Manoj Thakur
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.- (Materials and Energy Engg.)) (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. Atul Dhar
17	Course Coordinator (M.Tech.-(VLSI))	Dr. Srinivasu Bodapati
18	Course Coordinator (M.Tech.-(Communication and Signal Processing))	Dr. Siddartha Sarma
19	Course Coordinator (M.Tech.-(Power Electronics and Drives))	Dr. Himanshu Misra
20	Course Coordinator M.Sc. (Chemistry)	Dr. Bhaskar Mondal
21	Course Coordinator (M.Sc.-Applied Mathematics)	Dr. Muslim Malik
22	Course Coordinator (MA Dev.Studies)	Dr. Devika Sethi
23	Nominee-1: School of Engineering	Dr. Arpan Gupta
24	Nominee-2: School of Engineering	Dr. Mousumi Mukherjee
25	Nominee-2: School of Computing & Electrical Engineering	Dr. Manas Thakur
26	Nominee-1: School of Basic Sciences	Dr. Tulika Srivastava
27	Nominee-2: School of Humanities & Social Sciences	Dr. Saumya Dixit
28	Industry Member – 1	Dr. Nadeem Akhtar
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 (B.Tech.-EE)	Dr. Rahul Shrestha	Member
2	Course Coordinator (B.Tech.-EP)	Dr. Pradeep Kumar (SBS)	Member
3	Course Coordinator (M.Tech.-(Computer Science and Engg.))	Dr. Sriram Kailasam	Member
4	Course Coordinator (M.Tech.-Biotechnology)	Dr. Amit Prasad	Member
5	Course Coordinator (M.Sc.-Physics) + (I-Ph.D. (Physics))	Dr. C.S.Yadav	Member
6	Nominee-1: School of Computing & Electrical Engineering	Dr. Renu M Rameshan	Member
7	Nominee-2: School of Basic Sciences	Dr. Girish Sharma	Member
8	Nominee-1: School of Humanities & Social Sciences	Dr. Suman	Member
9	Research Affairs Secretary	Mr. Adesh Singh	Member

Special Invitee

Sl. No.	Name	
1.	Dr. Venkata Krishnan	Asso. Prof., SBS
2.	Dr. Sunny Zafar	Asst. Prof. SE
3.	Dr. Moumita Das	Asst. Prof. SCEE
4.	Dr. Shyamasree Dasgupta	Asst. Prof. SHSS
5.	Dr. Srikanth Sugavanam	Asst. Prof. SCEE
6.	Dr. Viswanath Balakrishnan	Asso. Prof., SE

PART-A

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

44.1 Confirmation of the minutes of 43rd meeting of Board of Academics:

The minutes of the 43rd Board of Academics meeting held on 21st October, 2021 were confirmed.

44.2 To consider modified proposal for B.Tech (Hons.) to B.Tech.-M.Tech. IDD students.

Dr. Shubhajit Roy Chowdhury, Course Coordinator presented a modified proposal for B.Tech. (Hons.) to IDD (Bioengineering) students. After due deliberations, the BoA recommended the proposal with minor modifications for consideration of the Senate and its approval. The modified proposal is placed as **Annexure-A.**

44.3 To consider renaming of Master of Science (by Research) to Master of Technology (by Research).

Dr. Sandip Saha, Program Coordinator, M.Tech (Structural Engineering) presented a proposal regarding renaming the Master of Science (by Research) to Master of Technology (by Research). The motivations of the proposal are to avoid confusion in eligibility degree requirements for jobs/admission after completing the research focused postgraduate engineering/technical degree and to keep both the options, i.e., Job Placement and Higher Studies, relevant for the graduates.

It has been observed that the M.S. students are not considered eligible to take part in the campus placement on several occasions due the confusion in the degree title (Master of 'Science', instead of 'Engineering' or 'Technology'). Further, the M.S. graduates are often not eligible to apply for Government Jobs where the eligibility criteria is based on post graduate degrees in Engineering or in Technology. In general, the M.Tech. degree is more acceptable/popular in Indian industry/academia than the M.S. degree in Engineering/Technology. The Board discussed the proposal along with the admission/graduation/placement statistics of the IIT Mandi MS program and comparison of the similar programs at other institutes of national repute.

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

44.4 To consider revision in the Ordinances and Regulations for the MS/PhD programme.

Prof. Chayan K Nandi, Associate Dean (Research) presented a proposal regarding revision in the Ordinances and Regulations for the MS/PhD programme to the BoA i.e.

(i) Categories of Admission – Part Time / ERP.
(ii) Conversion of MS/PhD programme from Full time to Part-Time.
(iii) Residential requirement for Part-Time scholars.
(iv) Course work requirement for PhD scholars in Engineering (12 or 24 credits)
(v) Constitution of APC/DC
(vi) Synopsis submission
(vii) Constitution of Viva Voce Board

After brief discussion, the BoA suggested further modification in the proposal for 'Course Work requirement for PhD scholars'. Further, the BoA recommended the other proposals

for consideration of the Senate and its approval. The modified proposal is placed as **Annexure-B.**

44.5 To consider the proposal to start a new programme i.e. M.Tech. in Mechanical Engineering with specialization in Machine Design.

Dr. Himanshu Pathak, Asstt. Professor, School of Engineering presented the proposal to start a new programme M.Tech. in Mechanical Engineering with specialization in Machine Design. After brief discussion, the BoA deferred the proposal and gave inputs for modification of the proposal.

44.6 To reconsider proposal on Dual Degree/Conversion to PhD Programme (PG+PhD).

Dr. Manas Thakur, the Chairperson of the committee presented the proposal for dual degree/conversion to Ph.D. to the Board of Academics. After brief discussion, the BoA recommended the proposal for consideration of the Senate and its approval. The final modified proposal is placed as **Annexure-C.**

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

(i) The Chairperson, Course Proposal Committee (CPC) presented the course description of the courses discussed in the 43rd BoA meeting. After brief discussion, the BoA approved the courses, as placed at **Annexure-D**.

(ii) The Chairperson, Course Proposal Committee (CPC) presented the following courses for consideration and approval of the Board of Academics. After brief discussion, the BoA approved the courses with minor modifications, as placed at **Annexure – E**.

Sl.No.	Course Code	Course Title	L-T-P-C	Remarks
1	CE 352	Transportation Engineering	3-0-0-3	Modification in existing approved course
2	CE 353P	Civil Engineering Drawing	0-0-2-1	
3	EE 642	Research Study	0-0-6-3	
4	EN 510	Electrochemical Systems for Energy Engineering	3-0-2-6	
5	EN 511	Computational Methods in Material Science	1-0-6-4	
6	EN 512	Structure-Property Correlations for Energy Applications	1-0-4-3	
7	EN 695P	Post Graduate Project-I	0-0-4-2	
8	ET 501	Power Electronic Applications in Electric Transportation	3-0-0-3	
9	ET 502	Embedded Systems and IoT for E-Transportation	3-0-2-4	
10	ET 503	Electrical Machine and Drives in Electric Transportation	3-0-0-3	
11	HS 544	Disaster Risk Management	3-0-0-3	
12	IC 231	Measurement and Instrumentation Practicum	1-0-3-3	
13	ME 520	Microwave based Manufacturing Processes	3-0-0-3	
14	ME 521	Vehicle Design and Dynamics	3-0-0-3	

One course, Modelling, Simulation and Control of HEV was deferred due to incomplete description.

44.8 Any other item with the permission of the Chair.

PART-B

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

-NIL-

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

-S/d-

Secretary, Board of Academics

-S/d-

Chairman, Board of Academics

Annexure-A

Proposal for B.Tech (Honours) provisions to B.Tech.-M.Tech Integrated Dual Degree (Bioengineering) students

R.28 Eligibility for Award of the B.Tech. Degree

A student should be declared to be eligible for award of the B.Tech. degree if he/she has:

R.28.1 registered and successfully completed all the requirements as per the curriculum of the program.

R.28.2 acquired a minimum of 160 credits satisfying all the course basket requirements and projects mentioned under R.3.7 and completed all other compulsory requirements such as the Internship, NSS/NSO/H&T requirements etc. within the stipulated time as mentioned under R.12.

R.28.3 satisfied the minimum residence requirement of eight (8) semesters. "Residence" implies being formally registered for academic work. Any time on a semester exchange at another institute/university, with the approval of the Dean (Academics), shall count towards this residence requirement.

R.28.4 secured a minimum cumulative grade point average (CGPA) of 5.0 in passed subjects.

R.28.5 no dues to the Institute, Hostels, Libraries, NSS/NSO/H&T etc.

R.28.6 no disciplinary action is pending against him/her.

R.29 Eligibility for Award of the B.Tech. (Honours) Degree

R.29.1 In addition to the general eligibility criteria mentioned for the award of regular B.Tech. degree under R.28, a student must earn additional 12 credits (over and above the required 160 credits for regular B.Tech. degree) relevant to her/his discipline as recommended by the Faculty Adviser to be eligible for B.Tech. (Honours) degree.

R.29.2 Student must do DP401P & DP402P: Major Technical Project and DP-301P: Interactive Socio-Technical Practicum (ISTP) and obtain a grade of 'B' or above in these courses.

R.29.3 Student should not have received 'F' grade throughout the B.Tech. program.

R.29.4 Student should secure an overall CGPA of 8.5 or more out of 172-174 credits.

Proposed amendments in the criteria for B.Tech (Hons.) of IDD students:

1. To be at par with R 29.1 students need to do extra 12 credits of discipline electives. This means they have to earn 218 instead of 206 credits for the award of the B.Tech (Hons.) degree.

2. Since an IDD student is required to do 34 credits of PGP, the requirement of 8 credits of MTP is waived off. However, to earn a B.Tech (Hons.) they are still required to do DP-301P: Interactive Socio-Technical Practicum (ISTP) and obtain a minimum grade of 'B' in it. These 4 credits of Interactive Socio-Technical Practicum (ISTP) can come from 22 credits of free electives contributing to 4 out of 22 credits allotted for free electives. Also, the students have to earn a minimum of 'B' grade in the PGP.

3. Student should not have received 'F' grade throughout the IDD program.

4. Student should secure an overall CGPA of 8.5 or more out of 218-220 credits.

Annexure-B

Modifications in the MS/PhD Ordinances & Regulations

Part-Time MS / PhD

(External Registration is be merged and only Part Time nomenclature be used in whole O&R document)

Presently in O&R

	Part Time	External Registration Programme (ERP)
Applicable on	Faculty members of J&K, H.P., Project staff, IIT Mandi staff	All India basis
Co-Guide requirement	No	Yes, Co-guide shall be also employed in the same organisation
Residential requirement	Minimum one semester	Minimum one semester
Experience	Atleast 2 years	Atleast 2 years

Main changes in O&R:

- External Registration may be merged with Part-Time and **only Part-Time nomenclature** will be used further.
- Requirement of Co-guide is removed (**On DC/APC recommendation**).
- Duration of residential semester is redefined.
- The provision of relaxation in residential requirement is introduced considering the radial distance of **50KM from IIT Mandi** or **extensive research/professional experience** of 12-14 years in an organization.
- Introduction of new clause regarding conversion of Regular PhD programme to Part-Time programme.

R.1 Categories of Admission

The applicant for admission to Ph.D. programme shall be in any one of the following categories:

(i) **Regular full time Research scholars including degree holders from foreign universities/institutions:**

a) Research scholar with MHRD assistantship.
b) Research scholar getting support from Govt. /Semi Govt. agencies (QIP, CSIR, UGC, DAE, DST, DBT, NBHM, JEST, ICCR etc.)
c) Research scholar supported by self or the employer (Sponsored)
d) Research scholar supported from project*

(ii) Part time Research Scholars including degree holders from foreign universities/ institutions:

a) Research scholar working as a regular employee in the Institute
b) Research scholar supported from project*
c) Research scholar working in other organizations recognized by IIT Mandi or having MoU for research purposes.

d) Individuals employed in R & D environments in scientific institutions or industries,national laboratories, reputed universities/colleges or employed in research/analysis jobs in public sector/private sector/ government in the case of management area. The candidates seeking admission under this category must have at least two years of work experience.
e) Young Engineering / Science faculty members of all Engineering Colleges/Universities including Agricultural, Pharmaceutical, Veterinary, Medical Colleges/Universities recognized by appropriate government agencies to pursue research degrees in Science / Engineering.

The research scholars pursuing Ph. D. degree in an academic area in other IITs or in a recognized Institute or University in Engineering/Technology/Sciences including Social Sciences may be given admission as lateral entry in the corresponding categories mentioned above, with credit transfer for the course work. *The research scholar working in a project will be full time, provided his research for Ph.D. is related to the project as certified by the supervisor, who is associated with the project. A research scholar whose topic for Ph.D. is unrelated to the project will be working part time for Ph. D. but may be given full time status after the project tenure is completed.

2.1.4 Institute staff members/Research scholars under QIP–Research scholars working on part time basis.

For Research Scholars in the above categories, the minimum educational qualifications are the same as prescribed for full time research Scholars in 2.1.1, 2.1.2 and 2.1.3 for admission to the Ph. D programme in the respective categories.

R.2.2 Additional Requirements

The research scholars may be admitted to the Ph. D programme under the part time category from a reputed University/ Institution/ Organization and they must have completed full time employment of two years' experience (experience may include stints at multiple reputed organizations).

- The sponsoring Organisation/Institution must have at least 5 years of its existence. Only persons engaged in R & D work in Technical / Scientific Institutions/ Industries or R & D Establishments are eligible**.** The Organization/Institution should have adequate facilities for carrying out research.

- Candidate admitted to the programme on part-time basis must continue to remain in the same organization and place of work until the research work is completed. If the candidate is transferred or joins a new organization before the submission of the thesis, he/she should get the approval from the new organization for continuation of the programme and IIT Mandi.

- Doctoral Committee may recommend requirement of a Co-guide at the place of work.

The list of eligible disciplines in which the minimum educational qualifications have to be obtained, will be provided by each School in the Admissions Brochure, which will be updated from time to time. The admission brochure will also include details about interdisciplinary research areas, which may be pursued by the research scholars for the Ph. D degree and the corresponding eligible disciplines given by the Schools.

The School or its Selection Committee may find fit to consider meritorious candidates from disciplines other than listed in the Admission Brochure if there is a good match between the educational / research background of the candidate and the proposed area of research.

Additional and stiffer criteria than the minimum educational qualifications given in R.2.1 may be set by the Selection Committee of the School from time to time for short listing candidates to be called for interview and or test.

(New Clause) R.2.5 Conversion from full time to Part Time PhD programme to take up employment outside the Institute:

The PhD scholars are required to complete the programme within the stipulated duration. In case a scholar gets an offer to join a government employment/ R&D Organisation / Academic Institute, the registration may be converted from full-time PhD programme to Part-Time based on the recommendations of DC, subsequent approval of the Dean (Academics)/Competent Authority, on the following conditions:

1 a) Minimum period of registration and residential requirement should have been completed
b) Course work is completed
c) Passed the Comprehensive Examination
d) Scholar should be at the advance stage of the programme and made a good, quantified number of research/ thesis progress of atleast 70% as recommended by DC.
e) submit time-bound plan of completion of the remaining requirement duly recommended by the DC.

2. The student must submit the offer letter from the institution /organization which he/she willing to join.

3. Details about the required research facilities at the institution/organization, which he/she proposes to join.

4. Within a month of joining the proposed organisation, the student must submit a “No Objection Certificate” from the employer.

(New Clause) Conversion from full time to Part Time MS programme to take up employment outside the Institute:

The MS scholars are required to complete the programme within the stipulated duration. In case a scholar gets an offer to join a government employment/ R&D Organisation / Academic Institute, the registration may be converted from full-time programme to Part-Time based on the recommendations of APC, subsequent approval of the Dean (Academics)/Competent Authority, on the following conditions:

1 a) Minimum period of registration and residential requirement should have been completed
b) Course work is completed
c) Scholar should be at the advance stage of the programme and made a good, quantified number of research/ thesis progress of atleast 70% as recommended.
e) submit time-bound plan of completion of the remaining requirement duly recommended by the APC.

2. The student must submit the offer letter from the institution /organization which he/she willing to join.

3. Details about the required research facilities at the institution/organization, which he/she

proposes to join.

4. Within a month of joining the proposed organisation, the student must submit a “No Objection Certificate” from the employer.

R.15 Minimum Period of Registration/Residential Requirement

(a) The minimum period of study and research for regular full time research scholars required at the Institute from the date of registration for the Ph.D. Programme in engineering to the date of submission of Ph.D. thesis shall be 24 months for research scholars with Master's Degree in Engineering / Technology; 36 months for research scholars with Master's Degree in Sciences, for research scholars directly admitted to the Ph. D Programme with Bachelor's degree in Engineering / Technology and for research scholars who update from the M.S/M. Tech Programme at IIT Mandi to the Ph. D Programme.

(b) The minimum period of study and research for regular full time research scholars from the date of registration for the Ph. D Programme in Sciences, Humanities and Social Sciences to the date of submission of the Ph. D thesis shall be 24 months.

(c) The minimum residential requirement for the Ph.D. scholar under part time basis not employed in the Institute is one semester.

(i) The s*cholars need to complete the residential semester requirement in single or multiple visits adding up to at least 16 weeks on campus (i.e. equivalent to one semester). . However, the minimum period of residency for each period should not be less than 2 weeks.*

(ii) *DC may specify a higher residency requirement based on the courses recommended as well as the background.*

(iii) *In case of Part-Time scholars employed at radial distance of less than 50KM from IIT Mandi campus, the scholar may be permitted by the Dean (Academics) to complete course work without residential requirement, as a day scholar, but should fulfill the a*ttendance requirement of the course (if applicable).

(iv) In case of extensive professional research experience as candidates having MTech/MArch/MBA degree from a reputed CFTI with at least 12 years of professional experience or candidates having BTech/MSc degree from a reputed CFTI with at least 14 years of professional experience, the credit requirement as recommended by the DC, can be completed in the form of project/dissertation/seminar, online courses/self-study courses etc. There would be no residency requirements for such candidates.

(d) Withdrawal from the programme is permitted for a semester or longer for reasons of ill health or other valid grounds as duly recommended by Doctoral Committee.

MS REGULATIONS

R.1 Categories of Admission

Candidates will be admitted to the M.S. by research Programme in Engineering/ Sciences including Social Sciences of the Institute by fresh admission or lateral entry from a similar program in another recognized institute, in one of the following categories:

(a) Regular full time scholars with or without MHRD assistantship/Institute fellowship/project support*.

(b) Regular Full time scholars admitted laterally in the beginning of any semester with transfer of credit

(c) Part time Research scholars who are staff members of the Institute or supported by project*.

(d) Research scholars under the Pat-Time programme sponsored by and employed in industry/organization

(e) Part time Research scholars from a reputed university/ institution/ organization employed within radial distance of 50KM from IIT Mandi.

*Those working for research as part of requirement of Master of Science, in the area of the project may become full time research scholar while those working in unrelated area may become part time research scholar.

R.9 Doctoral Committee (PhD)

The School Chairperson will intimate to the Dean, Academic, for each scholar the area of research, the name(s) of the guide(s) and Co-guide (if any). The School Chairperson will constitute the Doctoral Committee (DC) for a research scholar within 4 weeks of the date of joining of the scholar.

The following is the composition of the Doctoral Committee (DC):

1 The School Chairperson or his/her nominee
(If the Chairperson or his/her nominee happens to be the Guide of a scholar, a senior faculty member / previous Head of the school will be nominated by Dean (Academics)) ... **The chairman**

2. Research Guide and Co-Guide (if any) . **Member(s)**

3. A minimum of one faculty member preferably in related areas or discipline of the student's research topic . **Member**

4. External Member of the Institute. **Member (Optional)**

In case of conflict statement among the DC members, the decision will be taken based on majority of votes. The DC shall record views of all the members in such cases.

R.8 Academic Progress Committee (MS)

School Chairperson will intimate to the Dean Academic Research, for each scholar the area of research, the name(s) of the guide(s) and Co-guide (if any). School Chairperson will constitute the Academic Progress Committee (APC) for a research scholar within 4 weeks of the date of joining of the scholar.

The following is the composition of the Academic Progress Committee (APC):

1 School Chairperson or his/her nominee
(If the Chairperson or his/her nominee happens to be the Guide of a scholar, a senior faculty member / previous Head of the school will be nominated by **Dean Academics**)
The chairman

2. Research Guide and Co-Guide (if any). **Member(s)**

3. A minimum of one faculty member preferably in related areas or discipline of the student research topic. **Member**

4. External member of the institute (Optional)

In case of conflict statement among the DC members, the decision will be taken based on majority of votes. The DC shall record views of all the members in such cases.

R.25 Viva Voce Examination (PhD)

(a) The following is the composition of the Viva Voce Board:

1. School Chairperson or his/her nominee (if the Chairperson or his/her nominee happens to be the Guide of the research scholar, any other suitable faculty, will be nominated by the Dean (Academics) or his/her nominee) **Chairperson**

2. One of the examiners of the thesis **Member**

3. Research Guide(s) and Co-Guide, if any **Member(s)**

4. The International expert (only in Online mode) or any other subject specialist either from the Institute or outside from the panel recommended by the Doctoral Committee and nominated by the Dean (Academics) or his/her nominee. (**OPTIONAL**) **Member**

R.21 Synopsis (PhD)

(a) On satisfactory completion of the prescribed courses, the comprehensive examination and the research work, the scholar shall submit the requisite copies of the synopsis of his/her research work in the required format through the guide(s) for consideration of the Doctoral Committee.

(b) Prior to submission of the synopsis, the scholar is required to give at least two open seminar talks on the topic of his/her research.

(c) The scholars should fulfill one of the following publication-related criteria (publications/patent should be related to his/her research area):

i. At least two papers (published/accepted) in refereed SCI/SSCI/SCIE peer-reviewed journals/reputed conference proceedings **(justified by Doctoral Committee)**.
ii. At least one paper (published/accepted) in a Q1 journal.
iii. At least one journal paper/chapter in edited volume (published/accepted) published by highly reputed publication houses* or enlisted in ABDC journals [applicable for Humanities and Social Sciences] or two substantial translations - at least of the length of standard book chapter or journal article with the reputed publishing houses [for Translation Studies in SHSS].
iv. Filed atleast one patent. (Justified by the DC)

* SHSS should have a list of reputed journals/publishing houses in relevant areas.

The Doctoral Committee may recommend exceptional cases to Dean Academics, who will assess the matter and upon approval will report it to the Senate.

R.19 Synopsis (MS by Research)

(a) On satisfactory completion of the prescribed courses and research, research scholars under the M.S. by research Programme in Engineering/ Sciences including Social Sciences, shall submit to the Head of the School through their guide(s), requisite copies of the synopsis of the research work for consideration by the Academic Progress Committee.

(b) Prior to the submission of the synopsis, research scholars are required to give at least one seminar talk on the topic of their research work.

(c) Research scholars are required to publish the results of their research before submission of their theses in a refereed reputed conference proceedings or journal. The Doctoral Committee may recommend exceptional cases to Dean Academics, who will assess the matter and upon approval will report to Senate.

(d) The research scholars shall present the synopsis before the Academic Progress Committee. The Academic Progress Committee will, if it approves the work reported in the synopsis, permit the research scholar to submit the thesis and recommend a panel of at least six thesis examiners from outside the Institute, who are not current collaborators of the scholar or the guide(s).

Proposal for

PG+PhD Dual Degree Upgradation Options

A. Upgrade from MS by Research to MS+PhD
B. Upgrade from MTech to MTech+PhD
C. Upgrade from MSc to MSc+PhD
D. Upgrade from MA to MA+PhD

Indian Institute of Technology Mandi
Himachal Pradesh, India.

November 2021

1. Preamble

Many IITs have programs that allow students admitted as part of PG programs (MTech/MS/MSc) to upgrade to a dual-degree PG+PhD program, or admit students after an undergraduate degree for a PG+PhD program. The motivations (particularly for the former) from the perspectives of candidates and institutes are as follows:

Motivations for candidates:

- Save time in doing PhD (no re-application, courses and/or PG thesis waived off, can continue working on the same problem).
- Those having a clear mindset towards pursuing PhD in a certain area after undergrad also get the tick mark of a PG degree in their profile.

Motivations for institutes:

- Retain in-house trained PG students for PhD.
- Improve overall research quality.

2. Methodology and Scope

A committee, constituting Dr. Manas Thakur (chair), Dr. Manoj Thakur, Dr. Sunny Zafar, Dr. Sayantan Sarkar, Dr. Puran Singh and Mr. Vivek Tiwari was constituted by the Dean (Academics) in September 2021, to look into PG+PhD upgradation options for existing PG students of IIT Mandi. The committee studied in detail the existing policies in this regard at various IITs (old as well as new), conducted a survey to gauge the interest of PG students at IIT Mandi, and proposed the policies with respect to (i) eligibility; (ii) selection process; (iii) degree requirements; (iv) program/fellowship duration; (v) award of degrees; and (vi) exit option, for MTech+PhD, MS+PhD, MSc+PhD and MA+PhD upgradation options, as listed subsequently. The proposal was deliberated and updated based on the comments received in two Board of Academics meetings during October and November, 2021.

3A. Upgrade from MS by Research to MS+PhD

1. Interested MS scholars with minimum 8.0 CGPA across their MS course work at IIT Mandi can place a request to their Academic Progress Committee (APC), for upgradation to MS+PhD program under the same advisor. Upon approval, the APC of the scholar can be converted to a Doctoral Committee (DC) as per institute norms.
2. The scholar would need to complete a total of 24 credits of course work, and the courses already credited during MS can be considered towards the same by the DC.
3. The MS thesis of the upgraded scholar will be waived off, but he/she needs to submit a Comprehensive Literature Review (hereafter referred to as CLR) report and make a presentation to the DC, within one year of upgradation.
4. The PhD fellowship for the upgraded MS+PhD scholar would start from the date of upgradation and may be paid up to six years from the date of MS registration. All other PhD norms will be applicable as is from the date of upgradation.
5. The scholar would be awarded both the degrees (MS by Research towards partial fulfilment of the requirements of dual MS+PhD, and PhD) after fulfilment of the requirements of the PhD degree. Provisional MS degree may be issued after completion of the PhD synopsis.

6. In case the scholar exits the dual-degree program as per existing PhD ordinances, he/she may be allowed to leave with an MS by Research degree only after fulfilling the requirements of the baseline MS by Research degree.

3B. Upgrade from MTech to MTech+PhD

1. Interested MTech students with minimum 8.0 CGPA across the required MTech course work of first two semesters at IIT Mandi can apply for upgradation to MTech+PhD program based on an internal call made twice a year by the PG admissions (or equivalent) committee of the respective school. The committee may prescribe a higher shortlisting criteria as per the number of requests and need, and would interview the shortlisted candidates in their broad area of interest. Upon approval, a guide may be allotted and a DC be formed for the candidate as per institute norms.
2. The DC may prescribe additional courses beyond those already credited by the scholar, if needed, based on the research area of the scholar.
3. The Post-Graduate Project (PGP) of the scholar will be waived off, but he/she needs to submit and make a CLR report+presentation to the DC, within one year of upgradation.
4. The PhD fellowship for the upgraded MTech+PhD scholar would start from the date of upgradation and may be paid up to six years from the date of MTech registration. All other PhD norms will be applicable as is from the date of upgradation.
5. The scholar would be awarded both the degrees (MTech towards partial fulfilment of the requirements of dual MTech+PhD, and PhD) after fulfilment of the requirements of the PhD degree. Provisional MTech degree may be issued after completion of the PhD synopsis.
6. In case the scholar exits the dual-degree program as per existing PhD ordinances, he/she may be allowed to leave with an MTech degree only after fulfilling the requirements of the baseline MTech degree. Letter grades, as applicable, may be awarded for the PGP dissertation relative to the original batch of the scholar (either by the original evaluation committee or a committee empowered by the school chair).

3C. Upgrade from MSc to MSc+PhD

1. Interested MSc students with minimum 8.0 CGPA across the required MSc course work of first three semesters at IIT Mandi can apply for upgradation to MSc+PhD program based on an internal call made twice a year by the PG admissions (or equivalent) committee of the respective school. The committee may prescribe a higher shortlisting criteria as per the number of requests and need, and would interview the shortlisted candidates in their broad area of interest. Upon approval, a guide may be allotted and a DC be formed for the candidate as per institute norms.
2. The scholar would have to finish his/her MSc requirements within the stipulated duration of the MSc program (possibly by aligning the PGP dissertation with the area of PhD research).
3. The DC may prescribe additional courses beyond those already credited by the scholar, if needed, based on the research area of the scholar.
4. The PhD fellowship for the upgraded MSc+PhD scholar would start after finishing the MSc requirements. In case the scholar is not eligible for a fellowship at the time of upgradation, he/she will be allowed to start PhD without fellowship, and may be paid the same if he/she clears an examination that entitles fellowship, from the respective date. In both cases the scholar may be paid the fellowship up to six years from the date of MSc registration. All other PhD norms will be applicable as is after finishing MSc requirements.

5. The scholar would be awarded both the degrees (MSc towards partial fulfilment of the requirements of dual MSc+PhD, and PhD) after fulfilment of the requirements of the PhD degree. Provisional MSc degree may be issued after completion of the PhD synopsis.
6. In case the scholar exits the dual-degree program as per existing PhD ordinances, he/she may be allowed to leave with the baseline MSc degree.

3D. Upgrade from MA to MA+PhD

1. Interested MA students with minimum 8.0 CGPA across the required MA course work of first three semesters at IIT Mandi can apply for upgradation to MA+PhD program based on an internal call made twice a year by the PG admissions (or equivalent) committee of the respective school. The committee may prescribe a higher shortlisting criteria as per the number of requests and need, and would interview the shortlisted candidates in their broad area of interest. Upon approval, a guide may be allotted and a DC be formed for the candidate as per institute norms.
2. The scholar would have to finish his/her MA requirements within the stipulated duration of the MA program (possibly by aligning the PGP dissertation with the area of PhD research).
3. The DC may prescribe additional courses beyond those already credited by the scholar, if needed, based on the research area of the scholar.
4. The PhD fellowship for the upgraded MA+PhD scholar would start after finishing the MA requirements. In case the scholar is not eligible for a fellowship at the time of upgradation, he/she will be allowed to start PhD without fellowship, and may be paid the same if he/she clears an examination that entitles fellowship, from the respective date. In both cases the scholar may be paid the fellowship up to six years from the date of MA registration. All other PhD norms will be applicable as is after finishing MA requirements.
5. The scholar would be awarded both the degrees (MA towards partial fulfilment of the requirements of dual MA+PhD, and PhD) after fulfilment of the requirements of the PhD degree. Provisional MA degree may be issued after completion of the PhD synopsis.
6. In case the scholar exits the dual-degree program as per existing PhD ordinances, he/she may be allowed to leave with the baseline MA degree.

Common Note (for Options 3B, 3C and 3D). At the time of application, if the results of the second or the third semester courses (as applicable for MTech or MSc/MA students) are not known, the admissions committee may make a provisional offer for upgradation subject to fulfilment of the CGPA requirement.

Course number : BE302
Course Name : Bioelectric Systems Modeling
Credit Distribution : 3-0-2-4
Intended for : Core for IDD BE, Elective for other B.Tech students
Prerequisite : Understanding Biotechnology and its applications (IC136), Cell Biology (BE201), Electrical Systems around us (IC160)
Mutual Exclusion : NA

---

1. **Preamble:** The course aims at modeling biomedical systems in the electrical perspective and uses those models for further analysis of signal extraction from biomedical systems. The course deals with the electrical and magnetic modeling and analyses of human body systems. Also, the notion of control theory is extended for the understanding of homeostasis as applied to human body systems. Some discussion on signal extraction from biomedical systems and its initial conditioning will also be covered in this course.

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

A. Electrical modeling of cells: Charge transport mechanism in cells, application of circuit theory to cell analysis – electrotonus model, Hodgkin Huxley model for membrane current, voltage changes in cell over space and time. Biological cables –the axons, potential outside a long cylindrical cell, exterior potential for an arbitrary pulse, RC modeling of axon as a transmission line, electrical properties of organs and organ-systems. 14 hours

B. Magnetic modeling of cells: Magnetic field of a cell in an infinite homogeneous conducting medium, electromagnetic induction, modeling of exterior magnetic field of a cylindrical cell. 2 hours

C. Applications of electrical modeling for biosignal extraction from different organs:
A. Biosignal extraction from heart: Origin of cardiac action potential, electric dipole modeling of heart, atrial depolarization causing P wave, sequential ventricular depolarization causing QRS complex, sub-epicardial repolarization causing T wave, recording of electrocardiogram using leads, stimulating the heart – the pacemakers.
B. Biosignal extraction from brain: Origin of neuronal action potential, origin of electroencephalogram signals, understanding neural oscillations (Alpha- Beta-, Gamma, Delta- and Theta Waves).
C. Biosignal extraction at neuromuscular junction: Origin of action potentials at axon hillock, propagation of bipolar signals in muscle fibers, recording of electromyogram signals.

D. Detection of weak magnetic fields: Magnetocardiograms and magnetoencephalograms 8 hours

3. **Feedback and control:** Basics of control engineering – notion of open loop and closed loop systems, homeostasis from the electrical model perspective, single loop and multiple loop homeostasis, stability of systems, criteria of stability, example study in neurorehabilitation, closed loop control of blood insulin and glucose regulation, closed loop control of brain stimulation. 18 hours

Lab experiments: 28 hours

1. Cable model of neurons
2. Hodgkin Huxley's model of neurons
3. Modeling of exterior electric field of a cylindrical cell
4. Modeling of electromagnetic induction in living cells
5. Modeling of electrical conduction in heart
6. Modeling of electrical conduction in brain
7. Modeling of electrical conduction in muscles
8. Modeling a feedback loop with one and two time constant(s)
9. Modeling of homeostasis process
10. Stability analysis of physiological systems

4. Text books:

1. Irving P. Herman, "Physics of the human body", 2nd edition, Springer Verlag, 2016.
2. John D. Enderle, Susan M. Blanchard, Joseph Bronzino, "Introduction to Biomedical Engineering", Elsevier Press, 2015.

5. References:

1. Eugenio Culurciello, Wei Tang, Evan Joon Park, "Biomedical Circuits and Systems", CRC Press, 2017.
2. Harold S. Burr, "The Fields of Life. Our Links with the Universe", Ballantine Publishers, 1973.
3. Robert Berker, Gary Selden, "The Body Electric: Electromagnetism And The Foundation Of Life", Harper Collins Publishers, 1998.

5. Similarity Content declaration with existing courses:

S. No.	Course Code	Similarity Content	Approx. % of Content
01.	EE516	Hodgkin Huxley Model, ECG, EEG (5 lectures)	12%

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

-N.A.-

Course number : BE 305
Course Name : Bioethics and Regulatory Affairs
Credit Distribution : 1-0-0-1
Intended for : B. Tech M.Tech Integrated Dual Degree Bioengineering students
Prerequisite : IC 136 Understanding Biotechnology and its Applications
Distribution : Core for IDD BE and elective for others
Mutual Exclusion : None

---

1. **Preamble:** This course intended to serve as a broad introduction to the field of bioethics and regulatory affairs. The course will combine lectures with small-group case work that encourages students to explore ethical dilemmas in a faculty-supported, peer-educated environment. The course also provides a discussion on drug and pharmaceutical regulatory affairs.

2. Course Modules with quantitative lecture hours

Module 1. Introduction to Bioethics (4 hours)

Ethics and ethical theory, the nuremberg code, declaration of helsinki, the belmont report, history of ethics, justice and rights, liberty and morality. Deontology, utilitarianism and Principalism, Virtue ethics, Ethics of Care, Human Rights.

Module 2. Ethics of research involving human participants (5 hours)

Biomedical research involving human participants. Guidelines for research on children, Stem cell research, animal research etc. Ethical issues in Genetic research and studies involving Genetic information. Ethics of investigator-participant relationship, problems of randomized clinical trial, constitution of Ethics Committees, informed consent and its theoretical value (respecting autonomy, nonmaleficence, concept of confidentiality etc.), research on vulnerable population.

Module 3. Drug regulatory affairs (5 hours)

Pharmaceutical regulatory affairs, national regulatory affairs, drug approval and international drug regulations, regulatory affairs of controlled drug delivery system, regulatory requirements for product approvals, environmental concerns and regulations. National regulatory affairs and bodies – Central Drugs Standard Control Organization (**CDSCO**) headed by the Drug Controller General of India (DCGI).

3. Text books:

Text Book:

1. Ronald Munson, "Intervention and Reflection: Basic Issues in Medical Ethics 10th Edition, Cengage Learning, 2018
2. Beauchamp, Tom L and Childress, JamesF. 2019. Principles of Biomedical Ethics. New York and Oxford: Oxford University Press.

References:

1. Rachels, James and Stuart Rachels. 2012. Elements of Moral Philosophy. (5-7th editions), New York: McGraw-Hill.
2. Santoro, Michael A and Thomas M Gorriee. Ethics and the Pharmaceutical Industry, New York, Cambridge University Press.

5. Similarity Content declaration with existing courses: Nil (0%)

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

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

Course number : BE501
Course Name : Anatomy and Physiology
Credit Distribution : 3-0-0-3
Intended for : B. Tech – M.Tech Integrated Dual Degree Bioengineering students, M. Tech. Core for Integrated Dual Degree Bioengineering students with Specialization in Biomedical Bioengineering, Doctoral students, Elective for M.Tech Biotechnology or any other suitable M.Tech students.
Prerequisite : IC136 / BE 201/ BE 202 or equivalent /or course instructor approval
Mutual Exclusion : None

---

1. Preamble:

This course is designed to impart a fundamental knowledge on the structure and functions of various organs of the human body. The overall anatomy and physiology of organ systems and their coordination are being dealt in this course. The purpose of learning this course on human anatomy and physiology is for biomedical engineering students to provide a basic understanding of the various parts of the human body, their anatomical position and their functions. Describes the structure and functions of various organs of the human body. Further, the mechanisms in the maintenance of normal functioning, homeostasis and disease perturbation knowledge will be gained.

2. Course Modules with quantitative lecture hours:

Module I: Foundations of Anatomy, Physiology and homeostasis [4 hours]

Organization of the Human Body, Chemical Foundations –Atoms, Ions, Molecules, Bonds, Solutions comprising different specialized tissues, organs and organ systems.

Module 2 : Haemopoietic system, Lymphatic System and Endocrine system: [8 hours]

Composition and functions of blood and its elements, their disorders, blood groups (ABO classification) and their significance, mechanism of coagulation, Anaemias and its types, lymph organs. Anatomy and physiology of Pituitary, thyroid, parathyroid, adrenal and pancreatic glands, specific hormones and disorders of these glands, endocrine control of growth and metabolism; pineal, thymus.

Module 3 : Cardiovascular and Musculo-skeletal system [10 hours]

Anatomy and physiology of the heart, cardiac cycle; circulation of blood, heart rate, blood pressure, ECG and heart sounds, lymphatic vessel, systemic and portal circulation; vascular system –arteries, arterioles, capillaries, venules. Blood pressure and its regulation. Brief outline of cardiovascular disorders like hypertension, myocardial infarction, congestive heart failure, cardiomyopathies and cardiac arrhythmias. Anatomy and physiology of muscular system, types of muscle tissue –skeletal, smooth, cardiac, contraction, muscle fibre regulation, Osseous system - structure, composition and functions of the skeleton, physiological properties of skeletal muscles and their disorders such as Rheumatoid arthritis, Gout etc.

Module 4: Digestive and renal System: [10 hours]

Gross anatomy of the gastro-intestinal tract, functions of its different parts, various gastrointestinal secretions and their role in the absorption and digestion of food, peptic ulcer, ulcerative colitis, hepatic disorder. the renal system structure –Anatomy and physiology kidney; structure of the glomerulus, nephron and network of blood capillaries urinary tract, formation of urine, concentration of urine; regulation of acid-base balance; the chemical acid-base buffer systems of body fluids and Micturition, diuretics and kidney disease.

Module 5: Respiratory system: [4 hours]

Anatomy of lungs, respiratory tract, mechanism and dynamics of respiration, lung volumes, transport of oxygen and carbon dioxide, disorders like cyanosis, Gas transport between the Lungs and tissues. Regulation of respiration. Respiratory adjustments in health and diseases.

Module 6: Nervous System [6 hours]

Anatomy and physiology of brain, blood-brain barrier, spinal cord, structure and types of the neuron, synapses neurotransmitters, organization of spinal and cranial nerves, central and peripheral nervous system, autonomic nervous system, receptors membrane potentials –graded potentials and action potentials, physiology of vision, audition, olfaction, taste and skin.

3. Text books:

1. Guyton, A.C. and Hall, J.E. "Textbook of Medical Physiology", 13th Edition, Saunders, 2015.
2. Ganong, W.F. "Review of Medical Physiology", 26thEdition (A Lange Medical book series) McGraw –Hill (International Ed.) 2010.

4. References:

1. Waugh, Anne and Allison Grant "Ross and Wilson Anatomy and Physiology in Health and Illness", 12thEdition, Churchill –Livingstone / Elsevier), 2014.
2. Carola, R., J.P. Harley and C.R. Noback. "Human Anatomy & Physiology", 2ndEdition, McGraw –Hill, 1992. 3.Vander, A.J., J.H. Sherman and D.S. Luciano "Human Physiology: The Mechanisms of Body Function", 5thEdition, McGraw –Hill, 1990
3. Khurana, Indu "A Textbook of Medical Physiology" 2nd edition Elsevier, 2015.
4. Johnson, L.R. "Essential Medical Physiology", 3rdEdition, Academic Press / Elsevier, 2003.

5. Similarity Content declaration with existing courses: NIL (0%)

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

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

Not applicable

Course number	**: BE502**
Course Name	**: Design and Analysis of Bioalgorithms**
Credit Distribution	**: 2-0-2-3**
Intended for	**: Core for Dual Degree Bio Engg. students** **Elective for other B.Tech and M.Tech students.**
Prerequisite	**: IC152 – Computing and Data Science** **IC136 - Understanding Biotechnology & its applications** **IC260 – Signals and Systems**
Mutually exclusive	**: None**

1. Preamble:

The course is meant to cover some important considerations in developing algorithms across various bio-informatics and bio-signal processing applications. Each module involves some well-established algorithms / methods targeting particular tasks, which will be compared and contrasted in terms of aspects such as their theoretical principles, quality of performance, complexity, speed, memory etc. After the introduction, 2 modules are dedicated to bioinformatics algorithms, and the other two modules cover bio-signal processing methods.

2. Course Modules with quantitative lecture hours:

Module 1: Introduction: Background on genomics and proteomics, DNA-RNA gene, protein structures, Importance of Bio-algorithms, Bioinformatics algorithms and examples of algorithms designs, algorithm complexity and speed, Bio-signal processing algorithms and design considerations **(4 hours)**

Module 2: Combinatorial pattern matching algorithms for genomes: Hash Tables, Exact matching, Suffix Trees, Keyword Trees, Heuristic similarity search methods, approximate pattern matching**,** sequence similarity search, sequence alignment, BLAST, and motif finding **(9 hours)**

Module 3: Graph-based and Clustering algorithms: Graph terminologies and some basic algorithms, shortest superstring-based DNA sequencing, hybridization-based DNA sequencing, graphs for peptide sequencing, K-means clustering and Hierarchical clustering for gene expressions, graph-based clustering, phylogenetic tree reconstruction **(9 hours)**

Module 4: Bio-signal processing: Pre-processing considerations in bio-signals (for EEG and FMRI), signal decomposition methods, graph-based and clustering algorithms for

EEG and FMRI, feature extraction and their uses in diagnosis of diseases **(6 hours)**

3. Text books:

1. **N.C. Jones and P.A. Pevzner. An introduction to bioinformatics algorithms, MIT Press, 2004**
2. **K. Najarian, R. Splinter. Biomedical Signal and Image Processing, 2nd Edition, CRC Press, 2012**

4. References:

1. **T. Cormen, C. Leiserson, R. Rivest, C. Stein. Introduction to algorithms, 3rd Edition, MIT Press, 2009**

5. Similarity Content declaration with existing courses:

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	BE5XX – Computational Biology	Some target tasks in the bio-informatics modules may overlap. But the proposed course (BE3XX) focuses more on the details and analysis of algorithms for such tasks	20%
2.	CS403 – Algorithms Design and Analysis	The principles of analysis of algorithms in the first three modules are similar. However, the algorithms covered in the proposed course are different and have an bio-informatics context.	20%

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

Course number	**: BE503**
Course Name	**: Biosensing and Bioinstrumentation**
Credit Distribution	**: 3-0-2-4**
Intended for	**: B.Tech M.Tech Integrated Dual Degree Programme in Bioengineering (B.Tech Core course), elective for others**
Prerequisite	**: IC161 (Applied Electronics) and IC161P (Applied Electronic Lab) or equivalent, IC260 (Signals and Systems) or equivalent**
Mutual Exclusion	**: None**

---

1. Preamble:

The course aims at studying techniques of measurement, obtaining signals from biological systems and processing those signals for estimating various biological parameters. The general principles of measurements , sensing and instrumentation will be applied in various bio-instruments. The students will also have a current background on the basic principles of key analytical biotechnologies, and how these technologies allow sensitive and accurate detection, purification, and characterization of biomolecules.

2. Course Modules with quantitative lecture hours:

Topic 1: Measurement – SI units, systematic and random errors in measurement, expression of uncertainty - accuracy and precision index, propagation of errors, DC potentiometer; bridges for measurement of R, L and C, Q-meter, signal-to-noise ratio, responsivity of a sensor (Transformation of Input-to-output signal). **(4 Hours)**

Topic 2: Biosignals – Origin, nature, and types of Biosignals, Principles of sensing physiological parameters from plants and animals, Bioelectric signals and their characteristics. Chemical and electrochemical biosignals. **(3 hours)**

Topic 3: Sensors - Classification of transducers and their characteristics, viz. Voltage sensors, Optical sensors, Displacement/Pressure sensors and accelerometers, Chemical sensors, Acoustic sensors – basic principles, signal conditioning considerations, examples (e.g. biopotential electrodes, pulse oximeter, glucose monitor, hearing aid, etc.); Physical biosensors and associated signal conditioning circuits; Chemical biosensors; Antibody based biosensors, DNA based biosensor, Immunoassays for plant and animal pathogen detection, Enzyme linked immune-sorbent assays (ELISA), bio-luminioscent

technologies for pathogen detection; Optical sources and detectors: LED, Photo-diode, p-i-n and avalanche photo diode, optical nterferometers: applications in metrology; basics of optical sensing and LASER; basics of magnetic sensing.
(16 Hours)

Topic 4: Bioinstrumentation – Biopotential Amplifiers, Noise and artefacts and their management, Electrical Isolation (optical and electrical) and Safety of bio-instruments. Generation, Acquisition, and signal conditioning and analysis of biosignals. Principles of measuring blood pressure, bioamperometric enzyme electrode. (**15 hours**)

Topic 5: Analytical bio-techniques - Principles and applications of UV-Visible-NIR spectroscopy, fluorescence spectroscopy, MR spectroscopy, basics of chromatographic techniques, imaging techniques – principles and applications of microscopy. **(4 hours)**

Laboratory/practical/tutorial Modules: Design of measurement circuits, ELISA test, extraction of bio-signals, amplification and isolation of bio-signals, phase contrast microscopy, chemoluminiscence, fluorescence spectroscopy, MR spectroscopy, spectrophotometry, Pulse oximeter, blood pressure measurement device

3. Text books:

1. A.G. Webb, Principles of Biomedical Instrumentation, Cambridge University Press, United Kingdom, 2018.
2. J. G. Webster, Medical Instrumentation – Application and Design, 4e, John Wiley and Son, USA, 2020.

4. References:

1. R.S. Khandpur, Biomedical Instrumentation – Technology and Applications, Tata McGrawHill, India, 2017.
2. S.C. Mukhopadhyay, A.L. Ekuakille, Advances in Biomedical Sensing, Measurements, Instrumentation and Systems, Springer-Verlag, Germany, 2018.
3. J. R. Lakowicz, Principles of Fluorescence Spectroscopy, Springer Science & Business Media, 2013.
4. H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental Methods of Analysis, CBS publishers and Distributors, 2015.

5. Similarity with the existing courses:

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

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	Bioelectric Systems Modelling	BE302	Bioelectric signals and their characteristics, Generation, Acquisition, and signal conditioning and analysis of biosignals	7%
2.	Analytical Biotechniques	BY514	Brief introduction to different analytical techniques	5%

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

Not applicable

Course number : BE504
Course Name : Biomaterials
Credit Distribution : 3-0-2-4
Intended for : B. Tech-M. Tech. Integrated Dual Degree Bioengineering, Core for IDD BE and elective for others
Prerequisite : IC 136 Understanding Biotechnology and its Applications and IC 241 Materials Science for Engineers or Consent of Faculty Member
Mutual Exclusion : NA

---

1. **Preamble:** The objective of this course is to build a solid foundation of knowledge for biomaterial science and technology. The target is to teach the physical and biological principles that serve as the scientific basis for understanding the interactions of biological molecules and cells with biomaterials employed for different biomedical applications.

2. Course Modules with quantitative lecture hours:

Module 1: Introduction to Biomaterials(8 hours)

Introduction to biomaterials and its history, Properties of Biomaterials- physico-chemical, mechanical, biocompatibility and biodegradability, Surface properties of biomaterials, Biological responses and Cell-Biomaterial interaction

Module 2: Classes of Biomaterials (8 hours)

Polymeric materials and blends, Biopolymers and hydrogels, Metal based biomaterials, Ceramics and bioglasses; Adhesive and sealants, Elastomers

Module 3: Biomaterials Applications (20 Hours)

Applications of biomaterials in cardiology, nephrology, ophthalmology, dentistry and orthopaedics; Wound healing and dressing materials, skin substitutes and sutures, Applications of Biomaterials in Functional Tissue Engineering and drug delivery systems

Module 4: Device development, Standards and regulatory compliance (6 Hours)

Biomaterial device development and Regulation, Voluntary consensus standards, Commercialization, corporate considerations, Ethical issues, Clinical trials, Entrepreneurship and post market considerations in biomaterials.

Lab component: (28 Hours)

Lab component of the course will include synthesis/fabrication, characterisation, biocompatibility testing and application of biomaterials. The experiments include.

- Preparation of polymeric nanosphere and characterization
- Drug/Protein loading and release study with polymeric nanospheres
- Preparation and characterization of hydrogels/nanosponges
- Preparation and characterization of electrospun nanofibrous mats
- Biocompatibility Testing
- Preparation of Bioceramics and its characterization

3. Text books:

1. Biomaterials Science (Third Edition), An Introduction to Materials in Medicine, ISBN 978-0-12-374626-9, Academic Press, Edited by: Buddy D. Ratner et al.

2. Bikramjit Basu; Biomaterials Science and Tissue Engineering: Principles and Methods; Cambridge University Press; [ISBN: 9781108415156]; 2017.

4. References:

1. Bikramjit Basu; Biomaterials for Musculoskeletal regeneration: Concepts; Springer Nature, 2017 [ISBN: 978-981-10-3059-8].

2. Advanced Biomaterials: Fundamentals, Processing and Applications; John Wiley & Sons, Inc., USA (ISBN: 978-0-470-19340-2), September, 2009.

3. Biomaterials Science and Biocompatability, Fredrick H. Silver and David L. Christiansen, Piscataway, Springer, New Jersey.

4. Related journal articles

5. Similarity Content declaration with existing courses: NA

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

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

Course number : BE505
Course Name : Computational Biology
Credit Distribution : 2-0-2-3
Intended for : Core for Integrated Dual Degree Bioengineering students with Specialisation in Computational Bioengineering, elective for other B.Tech and Mtech students.
Prerequisite : Understanding Biotechnology and its applications (IC136), and Bioinformatics (BE304) or with permission of the instructor.
Mutual Exclusion : None

---

1. **Preamble:** The course aims at providing an understanding to the students about advanced topics in Computational Biology and their in-depth applications for solving biological problems. There are two goals for this course. The first goal is to introduce the students to the foundations of the field of computational biology. Namely, introduce the fundamental biological problems of the field, and learn the algorithmic and machine learning techniques needed for tackling them. The second goal of the course is to tackle the research frontiers of computational biology. The course will include practical sessions for the students to help them master some of the advanced bioinformatics techniques from hands-on experience. The course will cover the following broad topics:

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

A. Pattern matching: Finding regulatory seqeuences in DNA, Motif discovery, Exhaustive search, Greedy motif clustering, wordlets and motifs refinements, Probabilistic solutions (expectation maximisation, Gibbs sampling) (2 hours)

B. Genomic Analysis: (14 hours)

a. Genome assembly with Graphs and Networks,
b. Gene prediction, Hidden Markov models, Viterbi, expectation maximisation)
c. Next Generation Sequencing analysis (short read mapping, ChIP-seq and RNA-seq analysis)
d. Comparative genomics and genome rearragements
e. Population genomics, Medical genomics, Personal genomics, disease epigenomics, Systems approaches to disease

C. Phylogenetic Inferences: Introduction to phylogenetic inferences, Alignments to Distances, probabilistic models of divergence (Jukes Cantor, Kimura, hierarchy), Distances to trees, types of trees, algorithms for tree building (UPGMA, neighbor joining), optimality (least squared error, minimum evolution), Alignements to trees, alignment scoring given a tree, parsimony, greedy vs dynamic programming, maximum likelihood, Max-a-Posteriori, bootstrapping, Tree visualisation. (3 hours)

D. Structure prediction and Molecular modelling: RNA and protein structure prediction methods, homology modelling and ab – initio structure prediction methods, models of proteins, discrete conformational search, binding and docking, molecular dynamics simulations. (5 hours)

F. **Biological network analysis and modelling:** Gene regulatory networks, Protein interaction networks, Logic modelling of Cell signalling networks, network modelling, formulating models, nonlinear dynamics and stability, steady-state problems, parameter fitting and estimation, basic overview of the modeling of metabolic networks in genome scale by Flux Balance or modeling of reaction kinetic for smaller networks/pathways (4 hours)

Lab Course content: (28 hours)

The below mentioned 10 topics will be covered over the 14 weeks:

1. Pattern matching
2. Genome assembly
3. Gene prediction (prokaryotic and eukaryotic)
4. Read mapping and NGS data-analysis
5. Comparative genomics methods
6. Population genomics methods
7. Phylogenetic and analysis molecular evolution
8. Protein structural analysis (Secondary structure prediction and homology modelling)
9. Protein structural analysis (Ab-initio molecular modelling and simulation, docking)
10. Biological networks analysis

3. Text books:

1. Computational Molecular Biology: An Introduction 1st Edition by Peter Clote (2000), ISBN-13: 978-0471872528, ISBN-10: 0471872520
2. An Introduction to Bioinformatics Algorithms (Computational Molecular Biology), by Neil C. Jones and Pavel A Pevzner, (2004), ISBN-10 : 0262101068, ISBN-13 : 978-0262101066.

4. References:

1. Bioinformatics Algorithms: Techniques and Applications: 03 (Wiley Series in Bioinformatics) by Ion Mandoiu (Author), Alexander Zelikovsky (2008), ISBN-10 : 0470097736, ISBN-13 : 978-0470097731
2. Introduction to Bioinformatics. Arthur M. Lesk (3rd Edition) Oxford University Press.
3. Biological Sequence Analysis-Probabilistic Models of Proteins and Nucleic Acids, by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison. Cambridge University Press.
4. Bioinformatics and Functional Genomics 3rd Edition (Wiley-Blackwell) by Jonathan Pevsner. ISBN-13: 978-1118581780

5. Similarity Content declaration with existing courses:

S. No.	Course Code	Similarity Content	Approx. % of Content
01.	BY512	Gene Prediction, Phylogenetic analysis	10%

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

Course number : **CS511**
Course Name : **Applied Probability**
Credit Distribution : **2-0-0-2**
Intended for : **MTech (CSE), MS, PhD**
Prerequisite : **None**
Mutual Exclusion : **EE534, MA524**

---

1. Preamble:

The main objective of this course is to provide students a basic foundation in probabilistic and statistical methods. Upon completion of this course students should have the necessary prerequisite background in the topics related to probability and statistics to pursue courses in Machine Learning and Data Science.

2. Course Modules with quantitative lecture hours:

1. Sigma field. Review of axiomatic probability, conditional probability, and independence, Bayes' rule and applications. (3 hours)

2. Recap of random variables, discrete and continuous random variables, and functions of random variables. (2 hours)

3. Joint, marginal, and conditional distribution, Covariance and correlation, Multinomial, Multivariate Normal, Conditional Expectations. (2 hours)

4. Probability generating function, moment generating function and characteristic functions – properties and applications. (3 hours)

5. Markov chains, classification of states and chains, stationary distribution and limit theorem, Poisson process. Application of Markov Chain in Page Rank, text summarization etc.
(4 hours)

6. The convergence of random variables – basic results, inequalities (Markov and Chebyshev), the law of large numbers (weak and strong), central limit theorem,

hypothesis testing, (5 hours)

7. Concentration inequalities – Chernoff's bound, Hoeffding's inequality and their applications in parameter estimation and confidence interval of parameters. (3 hours)

8. Random vectors and covariance matrix. Random processes. Autocorrelation, cross correlation, power spectral density. Basic notion of ergodicity. (6 hours)

Laboratory/practical/tutorial Modules: NA

3. Text books:

3. Grimmett and Stirzaker, "Probability and Random Processes", 4/e, Oxford University Press, 2020.
4. Papoulis and Pillai, "Probability, Random variables and Stochastic processes", 4/e McGrawHill Europe, 2002.

4. References:

1. Erhan Cinlar, "Introduction to Stochastic Processes", Dover Books on Mathematics, 2013.
2. R. G. Gallager, "Stochastic Processes: Theory for applications", 1/e, Cambridge University Press, 2014.
3. S. M. Ross, "Stochastic processes", 2/e, John Wiley, New York, 1996.
4. J. R. Norris, "Markov chains", Cambridge University Press, Cambridge, 1999.
5. Joseph K. Blitzstein and Jessica Hwang, "Introduction to Probability", CRC Press.com
6. Kishor S Trivedi, "Probability & Statistics with Reliability, Queuing, and Computer Science Applications", Prentice Hall.

5. Similarity with the existing courses:

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

Course Code	Course Name	Overlap (%)
EE 534	Probability and Random Processes	>30%
IC210	Probability, Statistics and Random Processes	>30%
MA524	Probability and Statistics	>30%

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

It is a subset of the existing course EE534 with topics relevant for MTech CSE. The 2 credit structure for this course is already approved in the senate document for CSE MTech.

Course number : **CS512**
Course Name : **Matrix Theory**
Credit Distribution : **2-0-0-2**
Intended for : **MTech (CSE), MS, PhD**
Prerequisite : **None**
Mutual Exclusion : **MA512, EE522**

---

1. Preamble:

The main objective of this course is to provide students a basic foundation of linear algebra and let them understand its applicability in various AI/ML-related areas. Upon completion of this course, students should have the prerequisite background essentially required to appreciate the intricacies of AI/ML systems and can pursue Machine Learning and Data Science-related courses.

2. Course Modules with quantitative lecture hours:

1. **Background and review:** Linear system of equations, and their solutions, Linear transformation, Matrices, Determinant, Rank, Linear Vector spaces, Basis, Dimensions, Subspaces, Inner product, and orthogonality, Range space and null space, Eigenvalues and eigenvectors. Application: Examples of linear transformation such as rotation, translation, scaling, and eigen analysis. **(5 hours)**
2. **Norms for vectors and matrices:** Vector norms and their properties, Matrix norms, Error analysis in linear systems, Application: Examples of neural network optimization/regularizations. **(4 hours)**
3. **Eigenvalue Problems:** Condition numbers, and their application, Generalized Eigenvalue problems, Rayleigh Quotient. Application: Physical significance of eigenvalues and vectors and its relationship with PCA and Face recognition. **(4 hours)**
4. **Matrix factorization and Least square problems:** Singular value decomposition, generalized pseudoinverses, QR factorization, PCA, Least square problems. Application: Examples from dimensionality reduction and Clustering. **(5 hours)**
5. **Sparse matrices, their analysis, and algorithms:** Graphs and matrices, Sparse Gaussian elimination, Sparse eigenvalue, and singular value problems. Application: Relationship of sparse matrices with graph-based spectral clustering OR graph CNN's. **(4 hours)**

6. **Different types and matrices, their properties, and analysis:** Symmetric, stochastic, Random Matrices, Properties of positive definite matrices, Toeplitz, and Circulant matrices. Application: Toeplitz's relationship with convolution and deconvolution networks **OR** DSM based graph clustering **(6 hours)**

Laboratory/practical/tutorial Modules: NA

7. Text books:

1. Matrix Analysis, Roger A. Horn and Charles R. Johnson, Cambridge university press, 2012.
2. Matrix computations, Gene H. Golub and Charles F. Van Loan, 3ed Ed., John Hopkins University Press, 2012.

8. References:

1. Direct Methods for Sparse Linear Systems, T. A. Davis, SIAM, 2006
2. An Introduction to Matrix Concentration Inequalities, Joel Tropp, 2015
3. Topics in Random Matrix Theory, Terence Tao, AMS, 2012
4. Numerical linear algebra, Lloyd N. Trefethen and David Bau III, Siam, 1997.
5. Matrix analysis for scientists and engineers, Alan J. Laub, Siam, 2005.
6. Linear algebra in action, Harry Dym, American Mathematical Soc., 2013.
7. Linear Algebra and its application, Gilbert Strang, 4th Ed.,Cengage Learning
8. Matrix Analysis, Rajendra Bhatia, Springer 1997
9. Matrix Theory, David Lewis, 3rd edition, 2014, Allied Publishers

9. Similarity with the existing courses:

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

Course Code	Course Name	Overlap (%)
IC111	Linear Algebra	>30%
MA512	Linear Algebra	>30%
EE522	Matrix Theory	>30%

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

It is a subset of the existing course EE522 with topics relevant for MTech CSE. The 2 credit structure for this course is already approved in the senate document for CSE MTech.

Course number : CS513
Course Name : Discrete Mathematics
Credit : 4
Distribution : 3-1-0-4
Intended for : MTech CSE
Prerequisite : none
Mutual Exclusion: CS208 and CS511.

---

1. Preamble:

This course introduces students to formal reasoning and the mathematics of discrete structures which build the mathematical foundation of Computer Science. On completion of the course, students should be able to apply methods of mathematics in the areas of algorithm design, analysis and verification, automata theory and computability, knowledge representation, formal reasoning, information systems, and information security. In particular, the students should be able to

- use logical notation to define fundamental mathematical concepts such as sets, relations, functions and various algebraic structures, reason mathematically using such structures, and evaluate arguments that use such structures.
- model and analyse a computation process and construct elementary proofs based on such structures.

2. Course Modules with quantitative lecture hours:

1. Logic: (8 hours)

Propositional logic syntax and semantics (revision); proof system and deduction; soundness and completeness; principle of resolution; (ordered) binary decision diagrams; first order logic syntax and semantics; structures, models, satisfaction and validity; resolution; unification; proof systems; axiomatization, soundness, completeness and incompleteness theorems; undecidability of validity problem.

2. Infinite and Structured Sets: (12 hours)

Countable and uncountable sets, Cantor's diagonalization. Turing machines, Church-Turing Thesis. undecidability of the halting problem. consequences to the program verification problem.

Abstract Algebra: Homomorphism, Fundamental Theorem of homomorphisms, posets and lattices, formal contexts, monoids, semigroups, groupoids and groups, subgroups, cosets, Lagrange' theorem, rings, fields.

3. Combinatorics & Graph Theory: (12 hours)

Counting arguments, recurrence relations, generating functions (Ménage problem), formal power series (ring).

Basics of graph theory (revision), planar graphs (Kuratowski's theorem), minor graphs (Wagner's theorem, Robertson-Seymour theorem) matching and covering (Hall's theorem, Tuttle's theorem, Gallai/Milgram's theorem, connectivity and network flows, coloring (Brooks' theorem, Vizing's theorem), intersection and perfect graphs, sparse and dense graphs.

4. Probability Theory: (10 hours)

Recap of basic probability theory: axiomatic definition, discrete and continuous random variables, functions of random variables; joint, marginal, conditional distributions, Expectation and variance, Moment generating function and characteristic functions.

Moments and deviations (Stable marriage problem, the coupon collector's problem), Concentration inequalities (Chernoff and Hoeffding bounds), Markov Chains and random walks (Expanders). Monte Carlo method.

Laboratory/practical/tutorial Modules:

Tutorials on each of the above course modules (14 hours)

3. Text books:

1. K. H. Rosen, "Discrete Mathematics and Its Applications", 8/e, McGraw Hill Edu., 2019.
2. D. S. Dummit and R. M. Foote, "Abstract Algebra", 3/e, Wiley, 2004.
3. M. Mitzenmacher and E. Upfal, "Probability and Computing", 2/e, Cambridge Univ. Press, 2017.

4. References:

1. Dirk van Daalen: Logic & Structure, Springer, 2008.
2. Uwe Schoening: Logic for Computer Scientists, Springer, 2008

3. Michael Huth, Mark Ryan: Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge Univ. Press 2004.
4. B. Ganter, R. Wille: Formal Concept Analysis, Springer, 1996.
5. P. M. Cohn, Universal Algebra, Springer, 1981.
6. W. Wechler, Universal Algebra for Computer Scientists, Springer, 1992.
7. Reinhard Diestel, Graph Theory, 5/e, Springer, 2017.
8. Bela Bollobas, Modern Graph Theory, Springer, 1998.

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

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	CS208	A few modules in Logic and Countability	20%
2.	CS511	Topics in probability theory	25%

6. Justification of new course proposal if cumulative similarity content is >30%:
The course is in the core course basket of M.Tech(CSE) for students specializing in systems engineering. It cannot be taken alongside CS511 which is a 2-credit course for students specializing in Intelligent Systems.

Course number : CS551
Course Name : Human Computer Interaction
Credit Distribution : 3-0-0-3
Intended for : B. Tech./Masters/Ph.D.
Prerequisite : A programming course at the undergraduate level involving the use of Python, C#, HTML, or JavaScript for interface design.
Mutual Exclusion : None

---

1. Preamble:

This course will provide the skills to students for creating highly usable computer systems. It will also help students to advance the HCI theory and practice. Topics in the course would cut across human perception, ergonomics, cognition, psychology, task analysis, user interface design, interface programming, and system evaluation. Upon completing this course students would be able to evaluate user interfaces with human participants; apply cognitive walkthroughs to simulate a user's experience of an interface; be able to break a graphical user interface (GUI) activity sequence into the component actions; be able to choose an appropriate interaction design for a given need; and, be able to implement simple GUIs.

2. Course Modules with quantitative lecture hours:

Introduction to HCI **(08 Hours)**
Course overview; goals in HCI; importance of design for usability; usability goals and metrics; historical perspective: machinery, computers, PCs and GUIs, and the Internet; different types of users; usability guidelines, principles, and theories of attention, perception, memory, and decision making.

User experience and design **(12 Hours)**
Different methods and frameworks of design; tools, practices, and patterns of design; social impact analysis; task decomposition; cognitive walkthroughs; expert reviews and heuristics; heuristic evaluation; guidelines of usability; active use evaluation; motion and time studies; GOMS keystroke-level models; human-study methodologies and techniques; survey and interview instruments; metaphors; storyboards; acceptance tests; ethical issues; design cases.

Interaction Design **(10 Hours)**
Direct manipulation; 2D devices and 3D interfaces; teleoperation and presence; augmented and virtual augmented reality; certain design patterns; fluid navigation; speech recognition and production; human language technology; traditional command languages; models of collaboration and contexts; deciding the appropriate interaction design.

Design choices **(12 Hours)**
Choices for user experience (animation, color, error handling, etc.); timing of user experience (system response time influence); help menus; information search; data types

and data visualizations; grand challenges and future interfaces.

3. Text books:

Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, Niklas Elmqvist, and Nicholas Diakopoulos, Designing the User Interface: Strategies for Effective Human-Computer Interaction, 6th Edition, Pearson, USA, 2016

Dan R. Olsen Jr., Building Interactive Systems: Principles for Human-Computer Interaction, Cengage, 2010.

4. References:

Jeff Johnson, Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Guidelines, 3rd edition, Morgan Kaufmann, 2020.

Jenifer Tidwell, Charles Brewer, Aynne Valencia, Designing Interfaces: Patterns for Effective Interaction Design 3rd Edition, O'Reilly Media, 2020

Materials from other online sources [link1], [link2], and [link3]

5. Similarity with the existing courses:

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

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

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

Course number : **EN 503**
Course Name : **Energy Storage Technologies**
Credit Distribution : **3-0-0-3**
Intended for : **UG/PG (Elective)**
Prerequisite : **None**
Mutual Exclusion : **None**

---

1. Preamble:

The emerging energy generation sources such as solar and wind generates energy in variable patterns. Hence, energy storage is becoming of major importance to store and supply energy without any interruption. The energy storage can be in mechanical, electrochemical, or chemical forms.

2. Course Modules with quantitative lecture hours:

Module 1: Energy storage systems overview - Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market. (5 Hours)

Module 2: Thermal storage system-heat pumps, hot water storage tank, solar thermal collector, application of phase change materials for heat storage-organic and inorganic materials, efficiencies, and economic evaluation of thermal energy storage systems. (6 Hours)

Module 3: Chemical storage system- hydrogen, methane etc., concept of chemical storage of solar energy, application of chemical energy storage system, advantages and limitations of chemical energy storage, challenges, and future prospects of chemical storage systems. (5 Hours)

Module 4: Electromagnetic storage systems - double layer capacitors with electrostatically charge storage, superconducting magnetic energy storage (SMES), concepts, advantages and limitations of electromagnetic energy storage systems, and future prospects of electrochemical storage systems. (5 Hours)

Module 5: Electrochemical storage system (11 Hours)

(a) Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery& Metal hydride battery vs lead-acid battery.

(b) Supercapacitors- Working principle of supercapacitor, types of supercapacitors, cycling and performance characteristics, difference between battery and supercapacitors, Introduction to Hybrid electrochemical supercapacitors

(c) Fuel cell: Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-supercapacitor systems.

Module 6- Battery design for transportation, Mechanical Design and Packaging of Battery Packs for Electric Vehicles, Advanced Battery-Assisted Quick Charger for Electric Vehicles, Charging Optimization Methods for Lithium-Ion Batteries, Thermal run-away for battery systems, Thermal management of battery systems, State of Charge and State of Health Estimation Over the Battery Lifespan, Recycling of Batteries from Electric Vehicles. (10 Hours)

3. Text books:

- Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011)
- Ralph Zito, Energy storage: A new approach, Wiley (2010)

4. Reference:

- Pistoia, Gianfranco, and Boryann Liaw. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer International Publishing AG, 2018.
- Robert A. Huggins, Energy storage, Springer Science & Business Media (2010)

5. Similarity with the existing courses:

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

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

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

None. It is a revision of previous version of EN503

Course number : EE 537
Course Name : Power Quality Problems and Mitigation Techniques in Microgrids
Credit Distribution : 3-0-0-3
Intended for : UG/PG
Prerequisite : Power System (EE303) & Power Electronics (EE 309)
Mutual Exclusion : NA

---

1. Preamble:

The clusters of microgrids are the main building blocks of the smart grids, and these are the integral part of the modern power system. Due to the increased use of power electronic converters in domestic, commercial, and industrial & transportation sectors, the quality of power in distribution networks is deteriorating at an alarming rate. This is causing a number of problems to ICT industry, data centres and digital transformation. Moreover, these problems are aggravated by the direct injection of intermittent power from renewable energy sources. This course will cover the common power quality problems in the microgrids, techniques for enhancement of power quality, EV charging Infrastructure, associated power quality issues and their mitigation schemes.

2. Course Modules with quantitative lecture hours:

Unit 1: Power Quality Issues: Harmonics, frequency deviations, voltage fluctuations, voltage dips, swells, and interruptions. Power tetrahedron, power factor, and other figures of merit under balanced, unbalanced and nonsinusoidal conditions, power quality standards. **(8 Hours)**

Unit 2: Power Quality Enhancement: Generation of reference currents/voltages- natural frame of reference (abc), stationary frame of reference (αβ0) and synchronously reference frame (dq0) and symmetrical components frame reference (+-0). Advanced control architectures for hybrid AC–DC Microgrid-decentralized and hierarchical control- droop, primary, secondary and tertiary controls. Cooperative control for power quality enhancement in microgrids-active power Injection, reactive power-sharing, harmonic current sharing and voltage regulation via smart loads. **(10 Hours)**

Unit 3: Autonomous Control of Distributed Energy Resources in Microgrids: power sharing schemes for voltage unbalance and harmonics compensation in an Islanded microgrid- Power droop control, virtual impedance loop, local unbalance and harmonics compensation schemes. Effect of faults, overloading and loss of generation on power quality **(8 Hours)**

Unit 4: Power Quality Problems associated with Electric Vehicle Charging Infrastructure: Various configurations of chargers-contact and contact-less chargers, wired AC, DC charging-on-board slow, fast charging, off-board fast, rapid charging. Wireless chargers-inductive, capacitive and hybrid charging topologies **(10 Hours)**

Unit 5: Recent Trends and Case Studies: power quality enhancement in AC-DC hybrid microgrids under grid interactive mode, autonomous control of distributed energy resources,

power quality problems and their mitigation techniques for various EV charger topologies. **(6 Hours)**

Laboratory/practical/tutorial Modules:

3. Text books:

5. Arindam Ghosh and Gerard Ledwich, "Power quality enhancement using custom power devices", Springer Science & Business Media, 2012.
6. Hirofumi Akagi, Edson Hirokazu Watanabe and Mauricio Aredes, "Instantaneous power theory and applications to power conditioning", John Wiley & Sons, 2017.

4. References:

1. Narain G Hingorani and Laszlo Gyugyi, "Understanding FACTS: concepts and technology of flexible AC transmission systems," Wiley-IEEE press, 2000.
2. Selected papers, standards and reports

5. Similarity with the existing courses: Nil

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

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

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

Course number : **EN 509**
Course Name : **Functional Materials for Energy Engineering**
Credit Distribution : ***3-0-0-3***
Intended for : **UG/PG (Compulsory for MTech. in Materials and Energy Engineering, and Elective for others)**
Prerequisite : **None**
Mutual Exclusion : ME 609

---

1. Preamble:

This course is designed keeping the students coming from diverse fields in mind. It will provide a sound conceptual background in solid state physics necessary for understanding the functionality displayed by various materials especially for energy applications. Finally, to show the utility of the concepts learned in the course, some examples of functionality driven energy devices will also be discussed

2. Course Modules with quantitative lecture hours:

- **Module 1:** Introduction: Definition of functional materials, Different kind of functional materials; Inorganic and organic functional materials, Metal organic framework based materials, Hybrid organic-inorganic Perovskites, Use of functionalities of materials in fabricating devices, Causes for observed functionality in a material; Functionality arising due to (i) electronic, (ii) spin, and (iii) ionic degrees of freedom; Exploitation of combined effects in designing new functional materials. [4 Hours]
- **Module 2:** Functionality driven by electronic degrees of freedom: Atoms and crystalline solids; electronic states of atoms and crystalline solids; Formation of bands in crystalline solids; Band dispersions; Density of states; Metals, semiconductors and insulators; Direct and indirect band gap semiconductors; Formation of impurity bands in the p-type and n-type semiconductors; Electrons effective mass in a semiconductor; Transport and optical properties of a semiconductor; Opto-electronic materials. [12 Hours]
- **Module 3:** Functionality driven by spin degrees of freedom: Formation of magnetic moment in an atom; Spin and orbital part of magnetic moment in a solid; Magnetization of a solid; Diamagnetic, paramagnetic, ferromagnetic, and antiferromagnetic materials; Different kind of antiferromagnetic structures; Exchange interaction; Determination of magnetic transition temperature using mean-field theory; Formation of domain wall in ferromagnetic material; Soft and hard ferromagnets; CMR/GMR materials. [10 Hours]
- **Module 4:** Functionality driven by ionic degrees of freedom: Covalent, ionic and metallic solids; Formation of dipole moment; Polarization of a material; Paraelectric, ferroelectric, antiferroelectric, piezoelectric, and pyroelectric materials; formation of domain wall in ferroelectric material; Multiferroic materials. [6 Hours]
- **Module 5:** Functionality driven Energy Devices: Energy efficient devices, Light emitting diodes, Power Electronic Devices, Quantum computers and devices, Opto-electronic devices, Thermoelectric Devices, Electro caloric and Magneto caloric devices, Photovoltaic Devices. [10 Hours]

3. Text books:

- Solid State Physics by N.W.Ashcroft and N.D. Mermin, 1976, Harcourt College Publishers
- The Physics of Semiconductors: An Introduction Including Devices and Nanophysics by Marius Grundmann, 2010, Springer Berlin Heidelberg New York

4. References:

- Electronic Structure: Basic Theory and Practical Methods by R.M.Martin, 2004, Cambridge University Press
- Multiferroicity: the coupling between magnetic and polarization orders by K.F. Wang, J. – M. Liu, and Z.F.Ren, Advances in Physics 58, 321 (2009)

5. Similarity with the existing courses:

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

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	Functional Materials	ME609	Module 1-4	75%

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

The course ME609 is modified into EN 6XX to cater the basics of the Materials and Energy Engineering program. The modifications are brought in two areas-

1. The name is changed from Functional Materials to Functional Materials for Energy Engineering
2. The last module is changed from earlier ME 609 to provide a broader outlook of energy engineering devices and their material dependence. This course will act as the core course for M Tech MEE students and hence this modification was mandatory, especially to look after the students from varying backgrounds.

Course number : **HS 543**
Course Name : **Epidemics in World History: From the Black Death to COVID-19**
Credit Distribution : **3-0-0-3**
Intended for : **B.Tech/M.A./Ph.D.**
Prerequisite : **None**
Mutual Exclusion : None

---

1. Preamble:

How have epidemics been critical to the unfolding of global history? Exploring major epidemics from the 14th Century Black Death that swept across Europe to the current COVID-19 crisis, this course will examine the medical and social factors that give rise to global health crises and the geopolitical, cultural and social consequences of epidemics. Situating epidemics within the broader narrative of world history enables us to look at how epidemics have both connected and alienated different countries, communities, and individuals across lines of wealth, power, status, race, class and sexuality. The course will also reflect on what we can learn from the history of epidemics about how to rebuild, recover and move forward as societies in the aftermath of a global pandemic.

2. Course Modules with quantitative lecture hours:

1. Introduction: Medicine, Disease and World History [3 hours]
    a. Basic features of world history vs. area studies
    b. Benefits of placing medicine and disease within a world history framework
    c. Evolution of medicine and understanding of disease across time and space
    d. Emergence of modern scientific medicine
2. Medieval Pandemics: Leprosy and The Black Death [6 hours]
    a. Prevalence and treatment of leprosy in the middle ages
    b. The persecuted leper in medieval Europe: myth or reality?
    c. Global trading links in the 14th Century and the spread of the Black Death
    d. Medieval responses to the plague
3. Epidemics and Conquest: Smallpox and Syphilis in the Americas [4 hours]
    a. The Columbian Exchange
    b. Role of smallpox in the Conquest of the Americas
    c. Syphilis: the Columbian Theory
    d. Spread of syphilis and impact on society
4. Epidemics and Literature: Shakespeare in Quarantine, Tuberculosis in the Romantic Era [6 hours]
    a. Plague in 17th Century England and its effect on theaters

b. Representation of plague in Shakespeare's plays (*Romeo and Juliet, Othello, King Lear)*
c. Industrialization and tuberculosis
d. "Consumption" and Romantic Literature

5. Diseases and Colonialism: Cholera and Plague in India, Yellow Fever in Africa and Haiti, Malaria in Africa [6 hours]
    a. Role of yellow fever in the Haitian revolution
    b. The disease barrier of Africa
    c. Malaria, quinine prophylaxis and the scramble for Africa
    d. The science of bacteriology in the 19th Century
    e. British colonial policies and the spread of cholera in India
6. Epidemics and War: the 1918 Influenza pandemic [3 hours]
    a. Medical understanding of influenza in the early 20th Century
    b. Conditions of WWI that enabled spread of the disease
    c. Global mortality of the epidemic
7. Epidemics and Sexuality: AIDS in the 1970s [3 hours]
    a. Cultural and social factors in the emergence of AIDS in Africa and the United States.
    b. AIDS, stigmatization, and hysteria
8. Epidemics and Globalization: SARS, EBOLA, ZIKA, COVID-19 [9 hours]
    a. Social and ecological factors behind emergence of zoonotic viruses.
    b. Mobility, migration and spread of viruses.
    c. The role of WHO
    d. Superstition and cultural resistance to treatments
    e. Politics, the State, and national security
    f. Pandemics and behavioral change
9. Hope and recovery [2 hours]
    a. smallpox vaccine
    b. eradication drive for polio
    c. what we can learn from past medical successes and challenges.

3. Text books:

There is no textbook for this course. Readings will be assigned from the reference texts listed below.

4. References:

Arnold, David. *Colonizing the Body: State Medicine and Epidemic Disease in Nineteenth century India*, Berkeley and London, University of California Press, 1993

Barry, John M. *The Great Influenza: The Epic Story of The Deadliest Pandemic in History*. Penguin, 2005.

Crawford, Dorothy H. *Deadly Companions: How Microbes Shaped Our History*. OUP Oxford, 2007.

Crosby, Alfred W. *Ecological Imperialism, the Biological Expansion of Europe, 900-1900* Cambridge: Cambridge University Press, 1986.

Crosby, Alfred W. *The Columbian Exchange: Biological and Cultural Consequences of 1492*. Vol. 2. Greenwood Publishing Group, 2003.

Honigsbaum, M. *The Pandemic Century: A History of Global Contagion from The Spanish Flu to Covid-19.* Penguin Books, 2020.

Barroll, Leads, *Politics, Plague and Shakespeare's Theater: the Stuart years*, lthaca & London, Cornell University Press, 1991
Pati, Biswamoy and Mark Harrison (eds), *The Social History of Health and Medicine in Colonial India, Routledge Studies in Asian History*, London: Routledge, 2009.
Price-Smith, Andrew T. *Contagion and Chaos: Disease, Ecology, and National Security In The Era of Globalization*. MIT press, 2008.
Ranger, Terence, and Paul Slack, eds. *Epidemics and ideas: essays on the historical perception of pestilence*. Cambridge University Press, 1995.)
Rawcliffe, Carole, *Leprosy in Medieval England*, Woodbridge: Boydell Press, 2006
Snowden, Frank M. *Epidemics and Society: From the Black Death to the Present*. Yale University Press, 2019.
Tumbe, Chinmay, *Age of Pandemics (1817-1920): How they shaped India and the world*. HarperCollins, 2020.
Watts, Sheldon J. *Epidemics and History: Disease, Power, and Imperialism*. Yale University Press, 1999.

Additional resources:

Newspaper reports from NYTimes, The Guardian etc.

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

S.N.	Course Code	Similarity Content	Approx. % of Content
1.	Hs 391	Some discussion of Black Death and Conquest of Americas	10%
2.	HS 393	Some discussion of malaria and yellow fever in Africa	5%

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

Course Number	**:**	**ME518**
Course Name	**:**	**Conduction and Radiation**
Credits Distribution	**:**	**3-0-0-3**
Intended for	**:**	**MTech/MS/PhD in engineering streams.**
Prerequisites	**:**	**None**
Mutual Exclusion	**:**	**None**

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:

- **Module 1**: 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]
- **Module 2:** 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]
- **Module 3:** 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]
- **Module 4:** 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]

- **Module 5:** 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]
- **Module 6:** 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]
- **Module 7:** 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 Books

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%

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

Not Applicable

Course number : ME 519
Course Name : Technical communication for Engineers
Credit Distribution : 0-2-0-2
Intended for : MTech / MS / PhD in Engineering
Prerequisite : Nil
Mutual Exclusion : Nil

1. **Preamble:** Help students get comfortable with technical writing and presentations through (tutorials and) hands-on work in the labs. The course aims to impress the recipe-based approach to technical communication.

   Course Outline: This course will comprise two parts – technical writing and technical presentations. The course content constitutes two lab tutorial hours every week, stressing on the hands-on approach required to learning communication. The tutorial groups will be tutored by engineering faculty working in a related domain to ensure the technical aspect of the communication. Standard "models" will be presented to the students; the models will be analysed through comparisons with papers/reports and presentations in their field of study. By the end of this course, the students will become confident writing technical documents (report/dissertation) and preparing and presenting technical presentations. The students will be expected to submit assignments on the use of the "standard" models for writing technical reports on their planned research/project work.

2: Course modules with quantitative lecture hours:

- **Introduction:** What is technical writing and how it is different from non-technical writing. Standard writing models, building blocks and their description, and order of writing, case studies: establishing a clear distinction between "good" and "bad" writing (group activities are recommended), avoiding flowery language, word-processing tools (Latex). Writing assessment checklist. [4Hours]
- **Writing introduction section:** Structure of the introduction section, literature review and referencing, grammar (active/passive, signalling language), sentence structures and paragraphing, model development, testing model on relevant papers/reports, vocabulary (establishing significance, verbs for previous work, identifying gap, the present work). [5Hours]
- **Methodology:** Introduction, grammar and writing skills (tense pairs, 'a' vs 'the', countable and uncountable nouns, adverbs), model building, model testing exercise, vocabulary (general overview of the methods section, essential background information, providing precise details about materials and methods, justifying the choices made, taking appropriate care, comparison to other studies). [2Hours]
- **Results:** Importance of reporting objectively, correct use of tenses, the importance of sequence, comparison with previous work, model development, model testing, vocabulary (existing research, general overview, invitation to view results, key

results, sequence, frequency, quantity, causality, comparison with other results, problems with results, implications). [3Hours]

- **Discussion and conclusion:** Structure, grammar and sentence structure (ability, possibility, probability, certainty, opinion, obligation), modals, model development, model testing, vocabulary (revisiting previous sections, summarising key results, refining implications, relationship to existing research, achievement/contribution, limitations, future work, applications. [4Hours]
- **Abstract and title:** Abstract models, grammar and writing skills (choice of verb tense), length, language, model development, model testing, vocabulary (background, aim, problem, paper description, methods, results, achievements, implication, limitation), title and keywords. [2Hours]
- **Technical presentations:** Data analysis and interpretation, specification of uncertainty, choice of scales, data density, difference between graphs for a manuscript and graph for a ppt, structure, tools, graphics, practice presentations. [8Hours]

3. Text Book:

1. Glasman-Deal, H., Science Research Writing for Non-native Speakers of English, World Scientific, 2010.

4. Reference Books:

1. McCaskill, M. K., Grammar, Punctuation and Capitalization, NASA, Scientific and Technical Information Division, Washington DC, 1990.
2. Vidoli, C. A., Technical Report Writing, NASA Technical Memorandum 105419.
3. Paradis, J. G. and Zimmerman M.L., The MIT Guide to Science and Engineering Communication by, Cambridge, Mass.: MIT Press, 1997.

5: Similarity Content Declaration with Existing Course

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

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

Course number	**: IC240**
Course Name	**: Mechanics of Rigid Bodies**
Credit Distribution	**: 1.5-1.5-0-3**
Intended for	**: UG all branches**
Prerequisite	**: None**
Mutual Exclusion	**: None**

Preamble: Students learn to analyze the interactions of rigid bodies and be able to apply the principles in practical situations.

Course Content

Equilibrium: System isolation and the free body diagram, equilibrium conditions (7 hours)
Structures: Introduction, plane trusses, method of joints and method of sections, frames and machines. (7 hours)
Applications of friction (6 hours)
Kinematics of Rigid Bodies: Introduction, rotation, absolute motion, relative velocity, instantaneous center of zero velocity, relative acceleration, motion relative to rotating axes. (10 hours)
Kinetics of Rigid Bodies: Introduction, general equations of motion, translation, fixed axis rotation, general plane motion, Work-energy relations, virtual work, Impulse momentum equations. (12 hours)

Text Books:

1. J. L. Meriam, L.G. Kraige; Engineering Mechanics: Statics; Willey India Pvt. Ltd.
2. J. L. Meriam, L.G. Kraige; Engineering Mechanics: Dynamics; Willey India Pvt. Ltd.

References:

1. Beer, Johnston, Eisenberg, Sarubbi; Vector Mechanics for Engineers Statics and Dynamics; McGraw Hill Company
2. S. P. Timoshenko, D.H. Young; *Engineering Mechanics*, McGraw-Hill Book Company.
3. R.C. Hibbeler; Engineering Mechanics Statics and Dynamics, Prentice Hall.

Similarity Content declaration with existing courses: NIL (0%)

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

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

Course number : CE 352
Course Name : Transportation Engineering
Credit distribution : 3-0-0-3
Prerequisites : None
Intended for : UG
Mutual Exclusion : None

Preamble: With the present condition of increase in the population in the urban and major cities of the world, there needs a serious thought about the connectivity and transit facilities for goods, commodities and people. Transportation engineering majorly deals with the planning, design and analysis aspects of the connectivity with rail-road-water-air network with suitability, adoptability and passenger characteristics. Such a study would be helpful in understanding the requirements of a transportation facility and its working. The course includes various aspects of planning of network, design of pavements and failure analysis related to the aspects of road connectivity. It also includes various materials required, their characteristics and tests associated for adoptability. Also the course highlights the maintenance issues with the characteristics and studies required for traffic design. The student shall also be introduced with the other transportation system such as rail & air connectivity and recent developments of ITS.

Modules:

1. Introduction to transportation engineering: various methods of transportation and their importance, PMGSY, Golden quadrilateral and other road development plans of GOI. Planning of universal accessibility for public transport. **(6 hours)**

2. Geometrical design, camber, super elevation cross-sectional elements, sight distances, horizontal and vertical alignments, transition curves. **(12 hours)**

3. Highway Engineering: Pavement material and characterization, aspects of analysis and design of flexible and rigid pavements. **(7 hours)**

4. Highway Planning &maintenance, types of failure, evaluation and remedial measures. **(7 hours)**

5. Traffic Engineering: Vehicle and driver characteristics, Traffic design studies. **(5 hours)**

6. Introduction to rail and air transport system, intelligent transport system. **(5 hours)**

Text Books:

1. S.K. Khanna and C.E.G. Justo, 'Highway Engineering', Nem Chand Bros., 2002.
2. Kadiyali L.R., 'Principles and Practice of highway Engineering', Khanna Publishers, Delhi, 1992.

Reference Books:

1. Khistry, C.J. and B. K. Lall, ‘Transportation Engineering – An Introduction’, Prentice Hall of India Ltd., New Delhi, 2003
2. Garber, N.J., Hoel, L.A., ‘Traffic and Highway Engineering’, West Publishing Company, New York, 2014.
3. P. Chakroborty and A. Das, 'Principles of Transportation Engineering', Prentice Hall India, 2003.
4. S.C. Saxena and S.P. Arora, 'A text book of Railway engineering', Dhanpat Rai, 2001.

Similarity content declaration with existing courses:

Sl. No.	Course Code	Similarity Content	Approximate % of Content
1	NIL	NIL	NIL

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

Not Applicable.

Credit distribution : 0-0-2-1
Prerequisites : None
Intended for : UG
Mutual Exclusion : None

Preamble: Civil engineering drawing is a practicum course intended for B.Tech Civil Engineering students to explain various aspects of building drawings. This course will enhance the skill to understand, interpret and execute building projects in practice. This course will also serve as the basis for the preparation of material and cost estimates. The course has been designed to cover the fundamental aspects of building and structural drawings. The modules have been elaborated as follows.

Modules:

1. Course policies, signs and symbols, planning residential building. Consideration of universal accessibility for buildings. (**3 contact hours)**
2. Site planning. **(3 contact hours)**
3. Building components: foundations, brick, RC, stone, windows, doors, arches, staircase. **(10 contact hours)**
4. Residential building: announcement of project. **(2 contact hours)**
5. Detailing of RC elements: sections of beams, columns, footings and portal frames. **(6 contact hours)**
6. Detailing of steel connection: rivets, welding, nuts and bolts. **(4 contact hours)**

Text Books:

1. Balagopal T.S. Prabhu, K. Vincent Paul, and C. Vijayan, 'Building Drawing and Detailing', Spades publishers, Calicut, 1987.
2. M.G.Shah, C.M. Kale, and S.Y. Patki, ' Building drawing with an integrated approach to built environment 4^{th} Edn.', Tata McGraw Hill, 2002**.**

Similarity content declaration with existing courses:

Sl. No.	Course Code	Similarity Content	Approximate % of Content
1	NIL	NIL	NIL

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

Not Applicable.

Course number **:** EE 642
Course Name **:** Research Study
Credit Distribution **:**0-0-6-3
Intended for **:** M.Tech (VLSI) -

Prerequisite **:** Nil
Mutual Exclusion **:** Nill

Preamble: Research study course is brought into the realms of M.Tech (VLSI) programme to enable a student pursue a research topic of interest under the supervision of a faculty member hereinafter referred to as advisor for the research study. Research Study is designed to provide credit for field research, survey of literature leading to problem identification and extended knowledge in a focused field of study. The topic can be from academic or industrial research fields in the domain of VLSI.

Objectives (based action verbs at appropriate levels of Bloom's Taxonomy):

1. *Understand* in details a particular area of research through contemporary publications in that area.
2. *Analyze* the flow of research in a particular direction.
3. *Identify* the gap in that area.
4. *Formulate* a problem to identify that gap.
5. *Propose* an initial solution for the problem formulated.

Methodology guidelines:

1. A student enrolled in M.Tech (VLSI) programme has to register for 3 credits of research studies during winter break after 1st semester. The credits earned through the research study will be added to the credits earned during the 2nd semester.
2. A student may be given the option to choose the broad area of Research Study (academic or industrial research), viz. Device Physics, Fabrication Technology, Circuit Design or Systems, based on which advisor(s) may be allotted to the student.
3. The topic chosen by student has to be approved by the faculty advisor.
4. The role of the advisor(s) is to assist the student during the research study.
5. It is expected that the student will meet the advisor at least once in a week.
6. The report of the research study has to be submitted in the form of a Term Paper at the end of the winter break.
7. The course will culminate with a seminar being presented at the end of winter break.
8. The seminar will be evaluated by a committee of four members involving faculty advisor (or nominee), advisor for the research study, two experts in that area from the faculty members of IIT Mandi.
9. The seminar is supposed to test presentation skills, clarity of problem, quality of slides being prepared and question-answer session at the end of seminar.
10. The seminar can be an open seminar, although the decision of the four member committee will be final.
11. The student is expected to put in an effort of 30 hours per week for two and half months from start of winter break to its end.
12. In events of a dispute between the student and advisor, the matter has to be settled in consultation with faculty advisor which in exceptional cases may go to course coordinator, Chairperson (SCEE) or Dean (Academics).
13. The advisor reserves the right to reject a student with sufficient reasons if a student fails to deliver up to the expectations of the advisor. In such a case, a student will have to find

out his advisor on his own. However, the student will not be given any extra time to work out the new research study.

14. Any intellectual property (IP) generated out of an independent study is subjected to the IP regulations of IIT Mandi regarding sharing and ownership of IP rights.

Course number : **EN 510**
Course Name : **Electrochemical Systems for Energy Engineering**
Credit Distribution : **3-0-2-4**
Intended for : **UG/PG (Compulsory for MTech. in Materials and Energy Engineering, and Elective for others)**
Prerequisite : **None**
Mutual Exclusion : **None**

---

1. Preamble:

The course introduces the principles and applications of electrochemical systems, like batteries, fuel cells, supercapacitors etc. in the broader context of a renewable energy schemes. Students will understand the importance of electrochemical energy conversion and storage in energy systems of today and the future, especially in the framework of renewable energy scenarios with the help of theories and their realizations in laboratory experiments. Basics and key features of electrochemical devices will be discussed, and applications in the context of the overall energy system will be highlighted with focus on future mobility technologies.

2. Course Modules with quantitative lecture hours:

- **Module 1:** Electrochemical Engineering Fundamentals: Electrical Current/Voltage, Faraday's Laws; Electric Efficiency, and Mass Balance; Electrode Potentials and Electrode–Electrolyte Interfaces; Potential Difference; Electrochemical Cells- Galvanic, Electrolytic and concentration. [5 Hours]
- **Module 2:** Thermodynamics and Kinetics of an Electrochemical Cell: Electrochemical Cell Phases; The Nernst Equation; Mass Transfer Modes; Electrode Kinetics (Charger Transfer (Butler–Volmer Equation) and Mass Transfer (Diffusion Laws)); Limitations of Butler–Volmer Equation; Limiting Current Density; Galvanostatic Polarization; Polarization Methods- Linear Polarization, Tafel Extrapolation. [9 Hours]
- **Module 3:** Batteries: Introduction; Basic Li battery; Lead acid battery; Nickel-Metal Hydride (Ni-MH) Rechargeable Batteries; Metal–Air batteries; Self-discharge of batteries; Jump starting a car; Battery safety and toxicity. [6 Hours]
- **Module 4:** Fuel Cells: Introduction; Variety of fuel cells- proton exchange membrane fuel cell, Solid oxide fuel cell, Direct methanol fuel cell, Alkaline fuel cells; Hybrid fuel cell-battery system; Hydrogen Storage [6 Hours]
- **Module 5:** Supercapacitor: Introduction; Electric double-layer capacitors (EDLCs); Pseudocapacitor; Asymmetric hybrid capacitors; Concerns with cell assembly; Energy density and power density. [5 Hours]
- **Module 6:** Electroanalytical methods: Cyclic voltammetry and linear sweep voltammetry;

The need for a reference electrode; Impedance Spectroscopy; Chronoamperometry; The open circuit potential; Galvanometric charge-discharge; Ring disc electrode [8 Hours]

- **Module 7:** Electrochemical manufacturing: Electroplating; Electroless plating; Electrochemical machining and polishing. [3 Hours]

Laboratory/practical/tutorial Modules: [28 Hours]

- **Experiment 1:** Sample preparation
- **Experiment 2:** Cyclic voltammetry and linear sweep voltammetry
- **Experiment 3:** Impedance Spectroscopy
- **Experiment 4:** Chronoamperometry
- **Experiment 5:** Galvanometric charge-discharge
- **Experiment 6:** Ring disc electrode

3. Text books:

- Zhang, J., Zhang, L., Liu, H., Sun, A., & Liu, R. S. (Eds.). (2011). Electrochemical Technologies for Energy Storage and Conversion, 2 Volume Set (Vol. 1). John Wiley & Sons.
- Braun, A. (2018). Electrochemical Energy Systems. de Gruyter.

4. References:

- Dicks, A. L., & Rand, D. A. (2018). Fuel cell systems explained. John Wiley & Sons.

5. Similarity with the existing courses:

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

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	Energy Storage Technologies	EN503	Li-ion battery& Metal hydride battery vs lead-acid battery, Working principle of supercapacitor, Operational principleof a fuel cell	<10%
2.	Chemical Thermodynamics and Electrochemistry	CY514	Basic electrochemical thermodynamics, kinetics (Buttler Volmer), electrode potential	<5%

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

Course number : EN 511
Course Name : Computational Methods in Material Science
Credit Distribution : *1-0-6-4*
Intended for : UG/PG (Compulsory for MTech. in Materials and EnergyEngineering, and Elective for others)
Prerequisite : Instructor's consent
Mutual Exclusion : None

---

1. Preamble:

This course is designed keeping the students coming from diverse fields in mind. It assumes a initial knowledge of physics, chemistry and mathematics at undergraduate level. It will provide a solid conceptual background necessary for calculating the various physical properties of (especially energy based) materials mentioned below using standard first principle-based codes. Finally, the students will use ABINIT, AFLOW and JARVIS codes to calculate these properties with reasonable accuracy.

2. Course Modules with quantitative lecture hours:

Theory: Density functional theory, Pseudo potentials, Plane wave and Projector augmented wave methods, Exchange-correlation functionals, Self-consistent solutions, Density of states, Band structures, Optical properties, Electrical & thermal conductivities, Seebeck coefficient, Polarization, Piezoelectric tensor, Specific heat, Entropy, Free energy, Elastic tensors, Moduli of elasticity, phonon dispersion, and Machine learning. [14 Hours]

Laboratory/practical/tutorial Modules: [84 Hours]

Part-1: Introduction to the various features of ABINIT code. Calculations of properties related to (i) Photovoltaic materials: Density of states, Band structures, & Optical properties; (ii) Thermoelectric materials: Electrical conductivity, thermal conductivity, Seebeck coefficient, Specific heat, Entropy, Free energy; and (iii) Piezoelectric materials: Polarization, Piezoelectric tensor, Elastic tensors & Moduli of elasticity. [48 Hours]

Part-2: Introduction to the various features of AFLOW and JARVIS codes. Search of new materials with better (i) Electronic, (ii) Optical, (iii) Thermoelectric, and (iv) Piezoelectric properties. [20 Hours]

Project: Proposing and demonstrating various scenarios for improving the properties of the existing state-of-the-art Photovoltaic, Thermoelectric, and Piezoelectric materials. [16 Hours]

3. Text books:

1. Electronic Structure: Basic Theory and Practical Method, Volume 2 by Richard M. Martin, Cambridge University Press, 2020.
2. Machine Learning in Materials Science: Recent Progress and Emerging Applications by Tim Mueller, Aaron Gilad Kusne and Rampi Ramprasad; A Chapter in Reviews in Computational Chemistry, Volume 29, Editors: Abby L. Parrill and Kenny B. Lipkowitz, John Wiley & Sons, Inc., 2016

References:

1. Burke, Kieron. "The abc of dft." Department of Chemistry, University of California 40 (2007).

4. Similarity with the existing courses: NA

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

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

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

Course number : EN 512
Course Name : Structure-Property Correlations for Energy Applications
Credit Distribution: *1-0-4-3*
Intended for : UG/PG (Compulsory for MTech. in Materials and Energy Engineering, and Elective for others)
Prerequisite : IC241 (Materials Science for Engineers)/ Instructor Consent
Mutual Exclusion: None

---

1. Preamble:

The goal of this course is to understand the structure of materials at different scales and correlate the observed properties particularly in the context of design of materials for application in energy systems. The introduction of various characterization tools will play instrumental role in understanding and application of materials for energy domains. The course will provide a basic overview of materials characterization techniques employed for structural, microstructural, thermal, mechanical, and electrical property determination. Suitable preparation and processing method /heat treatment will be employed to bring out the effect of processing on structure-property correlation in energy materials. Finally, students will be made to use computational tools (such as origin / gnuplot / matlab) for dealing with raw data and doing the analysis themselves to strengthen their understanding and skills.

2. Course Modules with quantitative lecture hours: [14 Hours]

Module – 1: Introduction to energy materials; photovoltaics, electrochemical systems, thermoelectrics, solar thermal systems. Importance of materials characterization (2 hours).

Module – 1: Structure of Materials – Crystal structure, micro-structure, and macrostructure; Determination of crystal structure by diffraction, X ray diffraction and electron and neutron diffraction; Vibrational spectroscopy (IR and Raman spectroscopy) for structural characterization of materials. (4 Hours)

Module – 2: Microstructure determination by light, and electron microscopy (SEM and TEM); binary alloys and distribution of phases in microstructure. (2 Hours)

Module – 3: Thermal analysis by TGA-DSC; Determination of enthalpy, melting, decomposition and phase transition temperatures. (2 Hours)

Module – 4: Mechanical property determination by indentation and tensile test, Stress-Strain diagram (2 Hours)

Module-5: Basics of electronic band structure, Electrical and optical properties of energy materials, determination of bandgap, Absorption (UV-Vis), emission (Photoluminescence)

(2 Hours)

Laboratory/practical/tutorial Modules: [42 Hours]

Structural Characterization (Module-1):

1. Preparation and processing of specimen and structural characterization using XRD,Determination of crystal structure by X-ray diffraction in a diffractometer
2. Preparation and processing of specimen and structural characterization using FT-IR,and Raman spectroscopy

Microstructural Characterization (Module-2):

3. Preparation and processing of specimen and observation of microstructure in singlephase alloy under optical microscope, scanning electron microscope
4. Preparation and processing of specimen and observation of microstructure and electrondiffraction using transmission electron microscope

Thermal Characterization: (Module-3):

5. Preparation and processing of specimen and thermal characterization using TGA-DSC
6. Thermal conductivity measurement

Mechanical Characterization (Module-4):

7. Preparation and processing of specimen and characterization of mechanical propertyusing tensile test UTM
8. Preparation and processing of specimen and elastic modulus as well as hardnessmeasurements by indentation method.

Electrical and Optical Characterization (Module 5):

9. Preparation and processing of specimen and characterization of Current voltage measurement, electrical conductivity, opto-electrical property.
10. Preparation and processing of specimen for Absorption (UV-Vis), emission (Photoluminescence/fluorescence) spectroscopy and determination of band gap.

3. Text books:

- Robert E Reed-Hill and Reza Abbaschian, Physical Metallurgy Principles, Thomson, 2003reprint.
- R. E. Hummel, Electronic Properties of Materials, Springer, 4th ed. 2011

4. References:

- Mauro Sardela, Practical Materials Characterization, Springer New York, 2014
- A.R. West, Solid-State Chemistry and Its Applications, Wiley, 2014

5. Similarity with the existing courses:

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

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	Structure - Property correlation inmaterials for Energy Application s	EN612	Crystal structure,micro-structure andmacrostructure; Determination ofcrystal structure by X-ray diffraction and Determination ofcrystal structure by X-ray diffraction in a diffractometer	<10%

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

Course number : **ME 695P**
Course Name : **Post Graduate Project-I**
Credit Distribution : ***0-0-4-2***
Intended for : **MTech. in Materials and Energy Engineering**
Prerequisite : **None**
Mutual Exclusion : **None**

---

1. Preamble:

This course is aimed to provide a platform for the students to explore new ideas and solution methodologies for solving problems catering to the broader spectrum of materials/energy/materials-energy nexus. The students are expected to think independently and conduct requisite literature survey on advanced topics to work with respective adsviors during the winter term after 1st semester. This will cater the basis of their post graduate project work extending to ME 696P and ME697P.

2. Course Modules with quantitative lecture hours:

The students are expected to conduct their literature survey in the winter term based on the research topic the students and their advisors decide upon. Their level of satisfactory progress will be judged at the beginning of the 2nd semester based on the problem identification and their requisite literature survey. Their involvement on the project will be a key factor of their judgement and will contain various aspects like- discussion with the advisor, completion of literature survey, report writing and presentation.

3. Text books:

As suggested by advisor.

References:

As suggested by supervisor or the material student finds necessary while working on project

4. Similarity with the existing courses: NA

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

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

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

Course number : ET 501
Course Name : Power Electronic Applications in Electric Transportation
Credit Distribution : 3-0-0-3
Intended for : PG
Prerequisite : Power Electronics/Consent of the instructor
Mutual Exclusion : None

---

1. **Preamble:** This course is designed to build up an in-depth understanding among the PG students about the power electronics for electric vehicle applications. The major goal of this course is to familiarize the students with the operation and working principles of the power electronics converters for electric vehicle (EV) applications. This course will provide analysis and design of power electronics converter topologies in EV applications. This course is also helpful for UG students interested in doing projects in this field.

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

Module 1: Introduction to hybrid and electric vehicles (3 hours)

- Electrification concepts
- HEV architectures and classifications
- Technological trends
- Electric drivetrains

Module 2: Introduction to Power Electronics (7 hours)

- Basic power electronics concepts
- Overview of power semiconductor devices
- Various converters for EVs

Module 3: Power electronics Converters (12 hours)

- DC-DC converters
- AC-DC converters
- DC-AC converters

Module 4: Battery Connected Systems (6 hours)

- Battery pack
- Battery management system
- Thermal management system
- Body control unit

Module 5: Charging Infrastructure for EVs (6 hours)

- On-board charging
- Fast charging
- Battery-swapping station
- DC-microgrid based charging station

Module 6: Modelling and Simulation (8 hours)

- System design considerations
- Rating and sizing of electric drivetrain components
- Complete system modelling
- Simulation of the complete system

Laboratory/practical/tutorial Modules:

A laboratory course is proposed separately to support this course.

3. Text books:

1. A. Emadi, M. Ehsani and J. M. Miller, Vehicular Electric Power Systems: Land Sea Air and Space Vehicles, New York:Marcel Dekker, 2003.
2. J. Larminie and J. Lowry, Electric Vehicle Technology Explained, New York:Wiley, 2003.

4. References:

1. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics, Applications and Design," John Wiley & Sons, 2003.
2. M.H. Rashid, "Power Electronics: Circuits, Devices and Application" Pearson Education, Fourth edition,2017•
3. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles" 1st Edition, Springer, 2003.
4. B. K. Bose, "Modern Power Electronics and AC Drives" Pearson Education India; Edition 1, 2015

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

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		EE309		10

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

Course number : ET 502
Course Name : Embedded Systems and IoT for E-Transportation
Credit Distribution : 3-0-2-4
Prerequisite : Digital System Design (EE210) or equivalent
Intended for : PG
Distribution : Core for M.Tech in Electric Transportation students, elective for other advanced B.Tech /M.Tech students
Mutual Exclusion : NA

Preamble: The mainstream electric transportation is a promising technology that has evolved in the 21st century to provide a clean, green alternate mode of transportation in contrast to emissive vehicles that are highly dependent on fossil fuels, emit greenhouse gases and have poorer energy efficiency. Providing a safe, reliable, lightweight and efficient on-board electrical energy source, as well as the required charging infrastructure are the main challenges in electric transportation. Embedded Systems play a major role in electric vehicles where embedded systems form an integral part of the battery management system. The hardware part deals with cell monitoring, charge control, thermal management, and cell balancing. The software part with algorithms to estimate the state of charge and state of health provides accurate information about the internal state of the battery to the hardware parts, driver, and energy management units. In order to provide an efficient charging system, abilities of IoT to demonstrate the ubiquitous perception and the real-time interactive view in the smart grid system need to be explored. The proposed course aims at building up an in depth understanding among the advanced B.Tech / M.Tech / M.S./ Ph.D students of embedded systems and IoT and its role in electric transportation through a perfect synergy of class lectures and hands-on assignments.

Course content:

1. Introduction to embedded systems: Understanding an embedded system, design metrics, design challenges, technologies for embedded systems. (2 hours)
2. Custom Single Purpose Processor for Embedded Systems: Design of data-paths and controllers, finite state machines, custom single purpose processor design at RT level, optimizing custom single purpose processors, introduction to hardware description languages, modeling of custom single purpose processors using hardware description languages. (3 hours)
3. Introduction to FPGA: Introduction to complex digital systems design, notion of programmable logic devices, overview of FPGA architecture, realization of data-path and controller, timing analysis of data-path and controller, synthesis, placement, routing, performance optimization. (2 hours)
4. Introduction to Microcontrollers: Introduction to microcontrollers, overview of architecture of a typical microcontroller such as AVR microcontroller, addressing, assembly language programming, Memory and I/O interfacing, device drivers for I/O devices. (4 hours)
5. Sensors and Actuators: Basic principles of sensors and actuators, classification of sensors and actuators, interface methodology and circuits, integration aspects (3 hours)

6. Embedded Systems for Electric Transportation: Battery management system (BMS), cell monitoring, battery safety and protection, state of charge estimation, state of health estimation, cell balancing, thermal management, charging control, BMS architectures. (8 hours)

7. Introduction to IoT: Overview of Internet of Things, IoT architecture, Communication protocols (4 hours)

8. Protocols for Wired communication: Device configuration and protocols, e.g., CAN, LIN, FlexRay, MOST, Ethernet, OBDII, (5 hours)

9. Protocols for Wireless communication: Wifi, ZigBee, Bluetooth Low Energy (BLE) (5 hours)

10. IoT for Electric Transportation: Centralized charging scheme, decentralized charging scheme, performance comparison and evaluation. (6 hours)

Experiments for lab: 28 hours

1. Hardware modeling using hardware description language
2. Modeling a custom single purpose processor for electric vehicle applications
3. Hardware realization using FPGA
4. Interrupt handling through microcontroller
5. Stepper Motor control using microcontroller
6. Battery management using microcontroller
7. FPGA based battery management architectures
8. Designing a multiprotocol system
9. Wired communication using CAN bus, LIN, FlexRay, MOST, Ethernet, OBDII
10. TCP-UDP client server systems
11. IoT application layer protocols - MQTT-CoAP
12. Applications of IoT on centralized charging scheme
13. Applications of IoT in decentralized charging scheme

Text books:

1. Rui Xiaong, Weixiang Shen, "Advanced Battery Management Technologies for Electric Vehicles", Wiley publishers, 2019.
2. James K. Peckol, "Embedded Systems: A Contemporary Design Tool", Wiley publishers, 2009.

Reference books:

1. Peter Xiao, "Designing Embedded Systems and the Internet of Things (IoT) with the ARM mbed", Wiley publishers, 2018.
2. Edward Ashford Lee and Sanjit Arunkumar Seshia, "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", MIT Press, 2017.
3. Charles H. Roth Jr., Lizy Kurian John, "Digital Systems Design Using VHDL", Cengage Learning, Third Edition, 2016.

Similarity content declaration with existing courses:

Sl. No.	Course Code	Similarity Content	Approx. % of content
01.	EE529	Introduction to FPGA, Introduction to microcontrollers	14%
02.	EE536	Protocols for wireless communication	12%

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

Course number : ET 503
Course Name : Electrical Machine and Drives in Electric Transportation
Credit Distribution : 3-0-0-3
Intended for : UG/PG
Prerequisite : Electromechanics (EE 201), Control System (EE301) and Power Electronics (EE 309)
Mutual Exclusion : Nill

---

1. **Preamble:** Electrical machine and Drives is core course for Electric Transportation program. Since, speed control of electrical machines is the main objective. Therefore, this course deals with the fundamental concept of electric drives system which is supported by modelling and control of important electrical motors for Electric Transportation applications.

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

Unit/Topic 1: Introduction to Electric Transportation (5 Hours)

Example of EVs; State of the art in Electric Vehicle Technology, Overview of EV technologies, Fuel Cell Electric Vehicles, Hybrid Electric Vehicles (HEVs), Vehicle Dynamics and Drive cycle, Introduction to Railway Systems

Unit/Topic 2: Fundamentals of Electric Drive control (12 hours)

Control Block diagram, Reference frame Theory, dq-reference frame, PI- controllers Design, Hysteresis controller
Control Methods: Field oriented control, Direct torque control, Sensor less control, Model Reference Adaptive Control (MRAC) Approach, Sliding mode control
DC machine Drive: Closed loop Speed Control of DC Motor Through armature voltage control and field control, Regenerative Braking
Control of motors in the EV: Multi Wheel Drive (MWD) or All Wheel Drive (AWD) systems, Torque vectoring etc.

Unit/Topic 3: Induction Motor Drives (10 hours)

Induction Machines: Squirrel Cage Induction Machine and Slip Ring Induction Machines αβ and dq- modeling of Induction Machines, Inverters for Induction Motors, PWM Switching Inverters, Soft-Switching Inverters
Induction Motor Control: Voltage by Frequency Control, Field-Oriented Control, Direct Torque Control,
Design Criteria of Induction Motor Drives for EVs, Design Example of Induction Motor Drives for EVs, Application Examples of Induction Motor Drives in EVs and Railways

Unit/Topic 4: Permanent Magnet Brushless Motor Drives (11 hours)

PM Materials,
PM Brushless Machines: Structure of PM Brushless Machines, Principle of PM Brushless Machines, Modeling of PM Brushless Machines, Inverters for PM Brushless Motors, Inverter Requirements, Switching Schemes for Brushless AC Operation, Switching Schemes for Brushless DC Operation
PM Brushless Motor Control: PM Synchronous Motor Control, PM Brushless DC Motor

Control

Design Criteria of PM Brushless Motor Drives for EVs: Design Examples of PM Brushless Motor Drives for EVs, Planetary-Geared PM Synchronous Motor Drive, Outer-Rotor PM Brushless DC Motor Drive, Application Examples of PM Brushless Motor Drives in EVs and Railways

Unit/Topic 5: Introduction to Special Machines (4 hours)

Switched Reluctance machine (SRM), Synchronous Reluctance Machine (SyRM) etc.

Laboratory/practical/tutorial Modules: Nil

3. Text books:

3. K. T. CHAU , "Electric Vehicle Machines and Drives: Design, Analysis and Application", Wiley-IEEE Press, 2015.
4. Morris Brenna, Federica Foiadelli, Dario Zaninelli , "Electrical Railway Transportation Systems" Wiley-IEEE Press, 2018.

4. References:

1. Ned Mohan, Siddharth Raju , "Analysis and Control of Electric Drives: Simulations and Laboratory Implementation" Aug. 2020
2. John G. Hayes, G. Abas Goodarzi , "Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles
3. W. Leonhard, "Control of Electric Drives" 2001.
4. P. Vas, Sensorless Vector and Direct Torque Control, Oxford Science Publications
5. Boldea, S. A. Nasar, "Electric Drives ", Second Ed. CRC Press Taylor & Francis Group 2006.
6. Bose B.K., "Power Electronics and Variable Frequency Drives – Technology and Applications", IEEE Press, Standard Publisher Distributors. 2001
7. Rashid M., "Power Electronics- Circuits, Devices and Applications", 3rd Ed., Pearson Education.
8. Krause, P. C., Wasynczuk, O., Sudhoff, S. D., "Analysis of Electric Machinery and Drive Systems", New York, Wiley-Interscience.
9. S. K. Pillai, A First Course on Electrical Drives, New Age International Pvt. Ltd.
10. R. Krishnan, Electric Motor Drives: Modeling, Analysis, and Control, Prentice Hall, 2001.

5. Similarity with the existing courses:

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

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		EE508, EE604, EE528	8 hours	20%

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

Course number	**:** HS544
Course Name	**:** Disaster Risk Management
Credit distribution	**:** 3-0-0-3
Prerequisites	**:** None
Intended for	**:** UG/PG elective
Mutual Exclusion	**:** None

1. Preamble:

Disaster whether natural, anthropogenic or hybrid disrupts the normal course of life for living as well as non-living entities. While some disasters are inevitably natural and may be beyond human or technological control; many other disasters are closely linked with the path of developments chosen by modern society. Human beings were always exposed to risks, particularly natural risks. For the last couple of centuries, the kind, type as well as intensity of disasters have increased phenomenally particularly with human interventions in natural phenomenon, unchecked exploitation of natural resources, mismanagement and inabilities of regulatory bodies in managing and controlling various human activities that are closely associated with disasters. Industrial pollution, urban by-products, and the casual attitude of people risks the society at large. Further, the exposure to risk and vulnerabilities have universal as well as group specific dimensions. Approaches to mitigate and manage disaster require deeper awareness of the nature of disaster, exposure of varied social groups, available frameworks, policies and conventions. This course equips students with greater understanding of varied dimensions of natural as well as man-made disaster and helps students envisage effective measures, strategies that require adoption not only during disaster but also in pre- as well as post-disaster situations. Such an awareness helps not only in training for preparedness but also in designing approaches for effective planning to reduce and evade significant fatalities and damage. Put succinctly, the curriculum exposes students with varied dimensions of disaster, responses and strategies of people and agencies-- national and international, risk assessment, and techniques of risk management.

2. Course Modules with Quantitative Lecture Hours

Unit I: Understanding Disaster **(12 lecture hours)**

Basic Terms and concepts:

Structural failures, Pollution, Accidents, Hazard, Disaster, Catastrophes, Risk, Vulnerability, Resilience

Types of disaster:

Natural disasters: landslide, avalanche, volcanic activities, drought, flood, cyclone, tsunami, earthquake

Anthropogenic disasters: industrial pollution, biological and nuclear disaster, forest fire, oil spills, gas leak, radiations, household waste

Exposure to disaster and abilities to avert risks; and, Resilience

Global Conventions and National Frameworks

Inventories: Maps, Zonation, Scale, Frequency, Return period risk framework

Environmental risks and Climate Change: Global Conventions; National Frameworks

Unit II: Risk Assessment **(8 lecture hours)**

Hazard analysis: Hazard, vulnerability, susceptibility determination
Consequence analysis: categories, elements of risk, vulnerability
Risk: Analysis, estimation, assessment

Unit III: Risk Reduction Approach **(5 lecture hours)**

Structural measures
Non-structural measures
Total risk
Acceptable risk
Cost-Benefit Analysis

Unit IV: Response and Disaster Management **(10 lecture hours)**

Social Response: household, community, administrative
Technical Responses and Management of Disaster
International Conventions and Institutional and Legal Responses:
Disaster Management Act 2005/ Plan 2016/2019
National Policy on Disaster Management
National Guidelines and Plans on Disaster Management,
UNDP, UNDRR, UNSDR guidelines

Unit V: Sendai Risk Framework **(7 lecture hours)**

Precursors, Framework content, Actions and Schemes,
Risk Governance,
Recovery, Rehabilitate and Reconstruction (R-R-R)

Recent case studies from community level to national level disaster, mini projects (out of class assignments and activities)

3. Text Book:

(i) Ulrich Ranke. 2016. *Natural Disaster Risk Management: Geosciences and Social Responsibility*. Springer International Publishing

(ii) R Subramanian, Disaster Management, Vikas Publishing house pvt., ltd., 2018

4. References:

(i) Pandey, Mrinalini. 2014. *Disaster Management*. Wiley India

(ii) Ulrich Beck. 1992. *Risk Society: Towards a New Modernity*. Trans. by Mark Ritter. New Delhi: Sage Publications

(iii) Sendai Framework for Disaster Risk Reduction 2015-2030, UNDRR

(iv) Recently published reports - UNDRR

(v) National Disaster Management Guidelines- 2019, NIDM, NDMA, India

(vi) National Disaster Management Policy, 2009, GoI

(As the changes in disaster management act are drastic, the above references need to be followed as recently published material)

5. Similarity Content Declaration with Existing Courses:

Sl. No.	Course Code	Similarity Content	Approximate % of Content

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

Course number : **IC231**
Course Name : Measurement and instrumentation practicum
Credit Distribution : 1-0-3-3
Intended for : all the BTech branches
Prerequisite : None
Mutual Exclusion : None

1. **Preamble:** The objective of the course is to provide a brief knowledge of measurements and measuring instruments related to engineering. The basic idea of this course is to give the sufficient information of measurements in any kind of industry viz. mechanical, chemical, electrical, electronics, etc.
2. **Course Modules with quantitative lecture hours:**

- **Measurement fundamentals:** Fundamental and derived quantitates: static and dynamic, understanding, sensitivity, stability, resolution, accuracy, precision, calibration, and types of errors. **[1 hours]**
- **Analysis and usage of MATLAB:** Tools for FFT, Analysis of variance (**ANOVA**) and Taguchi Method to improve the quality of manufactured goods, and its applications to engineering, biotechnology, marketing and advertising. **[1.5 hours]**
- **Contact/non-contact Sensors:** classification of transducers and sensors, Contact and non-contact sensors/transducers: Strain gauge, Capacitive and inductive sensors, U-tube manometer, rotameter, Ventury meter, LVDT (linear variable differential transformer), Hall effect sensors, opto-electronics based sensors, touchless absolute/rotary position transducers, ultrasonic sensors, piezo-electric/piezo-ceramic sensors, proximity sensors, radiation sensors, thermal and magnetic sensors **[5 hours]**
- **Mechanical measurement:** stress/strain, displacement, force, torque, pressure, flow, level, temperature, sound, vibration, pollution and humidity measurement. **[3 hours]**
- **Biomedical instrumentation:** measurement techniques for ECG, EEG and EMG, Contact-less pacemaker sensor for pulse-detection **[2 hours]**
- **Digital data acquisition:** Use of signal conditioners, scanners, signal converters, recorders, display devices, A/D and D/A circuits in digital data acquisition, data multiplexing and operation of sample and hold circuits. **[1.5 hours]**

Laboratory Modules:

1. Temperature measurement using thermal sensors,
2. Flow measurement,
3. Experiment on LVDT,
4. Level/distance measurement using contact-less ultrasonic sensor,
5. Vibration/Sound measurement,
6. Chemical composition detection,
7. Bio-signal measurement,
8. Virtual instrumentation using Labview: data acquisition,

9. Project.

3. Text book:

1. *Handbook of modern sensors: physics, device and applications* by Jacob Fraden, Springer.
2. *Handbook of biomedical instrumentation* by R. Khandpur, TMH Publication.

4. Reference book:

1. *Measurement Systems – Application and Design* By E.O. Doebelin, TMH Publication.
2. *Industrial Instrumentation and Control* by S. K. Singh, TMH Publication.
3. A Primer on the Taguchi Method by Ranjit K. Roy, Society of Manufacturing Engineers.

5. Similarity with the existing courses:

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

Course Code	Course Name	Overlap (%)

Course number	**:** ME 520
Course Name	**:** Microwave based Manufacturing Processes
Credit distribution	**:** 3-0-0-3
Prerequisites	**:** None
Intended for	**:** UG/PG
Mutual Exclusion	**:** None

1. Preamble:

Introduce the reader to the use of microwaves in manufacturing. The basic interactions will be described, along with the basic equipment required to process materials. Examples of successful applications will be presented, as will an evaluation of the conditions or parameters needed for the successful application of microwaves to the processing of materials. Provide an assessment of the state-of-the-art of microwave processing as an industrial technology. Identify gaps, limitations, or weaknesses in the understanding of the use of microwaves in manufacturing, and suggest research and development to address these issues

2. Course Modules with Quantitative Lecture Hours:

Module-1: Introduction and Fundamentals (6 hours)

Perspective, Material Interactions, Microwave generators, wave propagation, waveguide modes, microwave applicators, Safety aspects in Microwave Material Processing

Module-2: Science and Modelling of microwave material interaction (10 hours)

Power absorption model and Maxwell's equations, dielectric properties, microwave penetration and power absorbed, material behavior during microwave interaction, heating mechanisms in microwave processing of materials: non-magnetic materials (conduction loss), magnetic materials (hysteresis loss, eddy current loss and residual loss), microwave absorption in characteristically different materials: insulators, metallic powers and bulk metals, composite materials

Module-3: Manufacturing Processes for Polymers (10 hours)

Polymers, Polymer composites, microwave assisted compression moulding (MACM), vacuum assisted resin infusion microwave curing (VARIMC), mechanism of processing, roles of process parameters, case studies, lab demonstration

Module-4: Manufacturing Processes for Metals and their composites (8 hours)

Surface Engineering, Physics of Microwave Glazing and Cladding. Concept of skin depth, Role of process parameters, advantages and limitations, case studies, lab demonstration

Module-5: Manufacturing Processes for Ceramics (8 hours)

Microwave sintering of ceramics, process parameters in sintering, microwave drilling of ceramics, process parameters in microwave drilling, case studies, lab demonstration

3. Textbooks

- Metaxas, AC and, and Roger J. Meredith. Industrial microwave heating. No. 4. IET, 1983.
- Pozar, D.M. Microwave engineering. John Wiley & Sons, 2011.

4. References:

- Dieter, G.E. and David J.B., Mechanical metallurgy. Vol. 3. New York: McGraw-hill, 1986.
- DeGarmo, E.P., J. Temple Black, Ronald A. Kohser, and Barney E. Klamecki. Materials and process in manufacturing. Upper Saddle River: Prentice Hall, 1997.
- Chawla, K.K. Composite materials: science and engineering. Springer Science & Business Media, 2012.

5. Similarity content declaration with existing courses:

Sl. No.	Course Code	Similarity Content	Approximate % of Content
1	NIL	NIL	NIL

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

Course number	**:** ME 521
Course Name	**:** Vehicle Design and Dynamics
Credit Distribution	**:** 3-0-0-3
Intended for	**:** M.Tech, MS, PhD, B.Tech 3rd/4th year students or consent of faculty
Prerequisite	**:** Basic Engineering Mathematics and Mechanics
Mutual Exclusion	**:** None

1. Preamble:

The course is a combination of basic concepts as well as advanced concepts of automobile engineering. Since it is designed for interdisciplinary program, an introduction to basic kinematics and dynamics is provided. This is followed by specific application in overall vehicle as well as specific parts or machines such as gears, differentials, suspensions etc.

2. Course Modules with quantitative lecture hours:

Unit 1: Basic Vehicle Mechanics (6 hours)

Kinematics, Dynamics - Equation of motion, acceleration, effect of grade, drag. Air flow around the vehicle, tire models, rolling resistance. Load and energy calculations in electric vehicle over drive cycle.

Unit 2. Vehicle Design (6 hours)

Roll cage design, camber and caster angle, Stability analysis.

Unit 3. Transmission (8 hours)

Manual gear box, gear ratio, automatic gear box. Torque speed characteristics. Torque convertors, clutch, brakes.

Unit 4. Road handling (8 hours)

Differentials system, Torque vectoring, Suspension. Double wishbone suspension system,

Unit 5. Steering (6 hours)

Rack and Pinion steering system, Ackermann Steering, power steering.

Unit 6. Vehicle Dynamics (10 hours)

Lumped mass modelling, Basics of vibration, Quarter car model, Longitudinal and Lateral dynamics.

3. Text books:

1. Gillespie, Thomas D. *Fundamentals of vehicle dynamics*. Vol. 400. Warrendale, PA: Society of automotive engineers, 1992.
2. Rill, Georg, and Abel Arrieta Castro. *Road Vehicle Dynamics: Fundamentals and Modeling with MATLAB®*. CRC Press, 2020.

4. References:

1. Husain, Iqbal. *Electric and hybrid vehicles: design fundamentals*. CRC press, 2021.
2. Heisler, Heinz. *Advanced vehicle technology*. Elsevier, 2002.

5. Similarity with the existing courses:

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

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

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