



DELHI TECHNOLOGICAL UNIVERSITY

**Minutes of
25th meeting
Academic Council**

held on 04.11.2020

Shahbad Daulatpur, Bawana Road, Delhi-110042

INDEX

Item No.	Description	Page No.
Agenda 25.1	Opening Remarks by the Chairperson.	2-3
Agenda 25.2	Confirmation of the minutes of the 24 th meeting of Academic Council held on 29.07.2020.	3
Agenda 25.3	Action taken report on the decisions taken in the 24 th meeting of the Academic Council.	3
Agenda 25.4	Approval for amendment in Recruitment Regulations for the posts of Professor, Associate Professor and Assistant Professor in the disciplines of Management (Delhi School of Management and University School of Management and Entrepreneurship).	4
Agenda 25.5	Approval for the proposal of "Internet of Things and 5G: Centre of Excellence in Electronics and Communication Engineering Department".	4-5
Agenda 25.6	Approval for establishment of Centre of Excellence for Research in Unmanned Vehicles (CERUV).	5-6
Agenda 25.7	Approval for Foundation Elective - Community Engagement for UG students of the University (for 2 credits).	6-7
Agenda 25.8	Approval for amendment/ addition in the Regulations of Ph.D. Ordinance, 2017.	8-11
Agenda 25.9	Approval for admissions in Ph.D for the students admitted in August, 2020.	11

Agenda 25.10	Formal registration of Ph.D. Students upon successful completion of course work and comprehensive examinations and approval of research Plan by respective DRCs.	12-13
Agenda 25.11	Cancellation/Withdrawal of admissions made during July 2020 to September 2020 for Ph.D. programme.	13
Agenda 25.12	To consider the recommendation of committee on converting the core courses of final year into elective courses and provision of Minor in B.Tech program in pursuance with the Ordinance 1B of 2018 for all B.Tech programmes of the University.	14-18
Agenda 25.13	Conversion of Core Courses of 7 th and 8 th semesters to Elective Courses.	18-19
Agenda 25.14	To consider the recommendations of Board of Studies of different Academic Departments with regard to introduction of Minor to be offered by various academic departments.	19
Agenda 25.15	Approval for the introduction of new elective courses in V, VI, VII and VIII semester along with syllabus for various B.Tech programmes at Delhi Technological University.	19-20
Agenda 25.16	Academic calendar for B.Tech first semester (AY 2020-21).	20-21
Agenda 25.17	To consider the recommendations of committee on matter of Dual/Joint professorship in the University.	21-23
Agenda 25.18	Approval for change of the 2 courses slot from DEC 7 to 8 and vice versa due to offering the MINOR Degree in B.Tech. Program.	24
Agenda 25.19	Approval for addition the course due to offering the MINOR Degree in B. Tech. Program.	24

Agenda 25.20	Confirmation of admissions of UG students admitted in Academic Year 2019-20 along with their upgraded/allotted disciplines for the consideration of Academic Council.	25
Agenda 25.21	Approval for enhancement of intake of students in MBA, BBA and B.A. (Economics) programmes in USME.	25
Agenda 25.22	To consider the proposal of conferment of degrees on the students who have successfully completed the requirements prescribed under the ordinances of the University.	26
Agenda 25.23	Approval for change of name of existing AICTE approved M.Tech Programme in Nano Science and Technology, M.Tech (NST) running in the Department of Applied Physics to M.Tech in Material Science and Technology.	27
Agenda 25.24	To consider and approve the recommendation of Board of Studies for introduction of additional new DEC's proposed in B.Tech. (EP) and minor correction in the name of courses being offered by Department of Applied Physics.	28
Agenda 25.25	Approval of Delhi Technological University Logo the Flag.	29-30
Agenda 25.26	Reimbursement of Rs.2000/- per student for internet charges for online classes.	30
Agenda 25.27	Approval for minor degree in the discipline of Economics and English, Department of Humanities.	31



DELHI TECHNOLOGICAL UNIVERSITY

Established under Govt. of Delhi Act 6 of 2009

(Formerly Delhi College of Engineering)

BAWANA ROAD, SHAHBAD DAULATPUR, DELHI-110042

No. F.DTU/Org/AC/Meeting/01(1)/10/Vol-XI/1436-58

Dated : 09/11/2020

Minutes of the 25th meeting of the Academic Council held online on 04.11.2020 at 11:00 a.m. using Google Meet due to lockdown declared by the Government to avoid spread of COVID-19.

The following members were present:

1. Prof. Yogesh Singh, Vice Chancellor, Delhi Technological University and Chairperson, Academic Council.
2. Prof. J.P. Saini, Vice Chancellor, Netaji Subhash University of Technology, Delhi (nominee of University Grants Commission)
3. Prof. B.R. Chahar, Professor, Civil Engineering, Indian Institute of Technology, Delhi (nominee of All India Council for Technical Education)
4. Prof. Surendra S. Yadav, Professor of Management, Indian Institute of Technology, Delhi
5. Prof. Smriti Srivastava, Head-Division of ICE, Netaji Subhash University of Technology, Delhi.
6. Prof. Tarun Kumar, Professor, Department of Mathematics, University of Delhi
7. Prof. R.S. Mishra, Dean (Outreach & Extension Activities)
8. Prof. Ashutosh Trivedi, Dean (Industrial Research Development)
9. Prof. Vishal Verma, Dean (International Affairs)
10. Prof. S.C. Sharma, Dean Academic (PG)
11. Prof. Madhusudan Singh, Dean Academic (UG)
12. Prof. S. Indu, Dean (Student Welfare)
13. Prof. Narendra Kumar (II), Dean (Student Discipline) & Chief Warden
14. Prof. Rajesh Rohilla, Dean (Alumni Affairs)
15. Prof. Samsher, Dean (Continuing Education), Registrar and Member Secretary, Academic Council, DTU
16. Prof. S.K. Singh, Head, Environmental Engineering Department
17. Prof. Nirendra Dev, Head, Civil Engineering Department
18. Prof. Vipin, Head, Mechanical Engineering Department
19. Prof. Rinku Sharma, Head, Applied Physics Department
20. Prof. Uma Nangia, Head, Electrical Engineering Department
21. Prof. Sangita Kansal, Head, Applied Mathematics Department
22. Prof. Kapil Sharma, Head, Department of Information Technology
23. Prof. Rajni Jindal, Head, Computer Science & Engineering Department
24. Prof. S.G. Warkar, Head, Applied Chemistry Department
25. Prof. N. S. Raghava, Head, Electronics & Communication Department
26. Dr. Nand Kumar, Head, Department of Humanities

27. Prof. Jai Gopal Sharma, Head, Department of Bio-Technology
28. Prof. Ranganath M. S., Head, Department of Design
29. Prof. Rajan Yadav, Head, Delhi School of Management
30. Prof. R.C. Sharma, Director, University School of Management and Entrepreneurship
31. Prof. Naokant Deo, In-charge, B.Tech (Evening) Department
32. Sh. Kamal Pathak, Controller of Examinations
33. Prof. Pragati Kumar, Professor, Electrical Engineering Department
34. Prof. Reeta Wattal, Professor, Mechanical Engineering Department
35. Prof. V.K. Minocha, Professor, Civil Engineering Department
36. Sh. Rajesh Birok., Associate Professor, Electronics and Communication
37. Dr. M. Jayasimhadri, Assistant Professor, Applied Physics Department
38. Ms. Ishika Jain, Student Representative
39. Mr. Shivam, Student Representative

Following persons have also been invited to attend the meeting as special invitee:

1. Prof. M.M. Tripathi, Director, IQAC
2. Dr. Manoj Kumar Sharma, Chief Executive Officer, DTU-Innovation and Incubation Foundation
3. Dr. Rama Kant Shukla, Librarian
4. Sh. D.P. Dwivedi, Consultant, Finance & Planning
5. Prof. Rajeshwari Pandey, Associate Dean Academic (UG)
6. Dr. Ruchika Malhotra, Associate Dean, Industrial Research Development
7. Dr. Ram Singh, Associate Dean

Agenda 25.1 : Opening Remarks by the Chairperson.

Hon'ble Vice Chancellor welcomed all the members of Academic Council in its 25th meeting held online on 04.11.2020. He informed the members that the University Convocation has been scheduled on 24.12.2020 and Prof. Yogi Goswami has consented to be the Chief Guest of the Convocation. The Convocation will be held online. He further informed that the admission for first year UG & PG programmes are going on and for some programmes the admissions have been completed. The classes have already been started for remaining semesters.

The placement of students even during the pandemic period has been very good and upto 3rd November, 101 Companies have visited the campus and offered 600+ jobs to the students with the maximum of 51.7 lakh package. The Companies are also offering paid internship to the students and 201 offers have been given to the students and the highest stipend of Rs. 2 lakh per month. We appreciate the efforts made by T&P Department and his team.

Regarding Ranking, DTU has been placed at 801+ ranks by Times Higher Education Ranking in 2020 compared to 1001+ bracket in the last year. The Computer Science and Engineering Department has been placed at 601+ bracket by Times Higher Ranking System in 2020.

Regarding New Education Policy, he informed that many of the schemes of DTU have already been aligned with the new education policy including Choice Based Credit System. Regarding flexible curriculum as envisaged in new education policy, he informed that we are coming up with the major and minor specialization in all our UG programmes from this academic year and the agenda for the same is being placed in this Academic Council meeting. Regarding Research Publication, he informed that about 500 Research Papers (Scopus Index) have been published by B.Tech students. The total 1000+ Research Papers have been published in the last year. Regarding number of Ph.D awards, total 53 candidates have already fulfilled the requirement of award of Ph.D and we are targeting to award of 70 Ph.Ds in the coming Convocation. Teaching is going on online mode and labs are operational for Ph.D students and also for those who wish to work in the laboratories. Looking at the present pandemic situation, we may have to go for online mode in the next semester also.

Agenda 25.2 : Confirmation of the minutes of the 24th meeting of Academic Council held on 29.07.2020.

The minutes of the 24th meeting of the Academic Council held on 29.07.2020, were circulated among all the members vide forwarding no. F.DTU/ORG/AC/Meeting/01(1)/2010/Vol-XI/513-29 dated 31.07.2020.

No comments received from any of the members.

The Academic Council confirmed the minutes of its 24th meeting held on 29.07.2020.

Agenda 25.3 : Action taken report on the decisions taken in the 24th meeting of the Academic Council.

Action Taken Report on the decisions taken in the 24th meeting of the Academic Council held on 29.07.2020 was placed before the Academic Council.

In respect of point number 24.4 in the Action Taken Report, the Controller of Examinations keeping in view of the current pandemic situation, suggested that the same evaluation criteria may be considered in the next semester also.

The Academic Council noted and took the Action Taken Report on record.

○ **Agenda 25.4 : Approval for amendment in Recruitment Regulations for the posts of Professor, Associate Professor and Assistant Professor in the disciplines of Management (Delhi School of Management and University School of Management and Entrepreneurship).**

It was submitted to the Academic Council that the recruitment for direct recruitment to the post of Assistant Professor, Associate Professor and Professor in the discipline of Management has been revised considering Recruitment Regulations of AICTE & UGC notifications vide Gazette Notification dated 01.03.2019 & 18.07.2018 respectively.

The Academic Council is hereby requested to consider the **revised recruitment regulations** for direct recruitment to the post of Assistant Professor, Associate Professor and Professor in the discipline of Management. Revised Recruitment Regulations for the posts of Professor, Associate Professor and Assistant Professor in the disciplines of Management.

Decision : The Academic Council considered and recommended the amendments in Recruitment Regulations with few modifications for the posts of Professor, Associate Professor and Assistant Professor in the disciplines of Management (Delhi School of Management and University School of Management and Entrepreneurship) to the Board of Management for approval. The modified Recruitment Rules are placed in *Annexure at pages 01 to 10*.

Agenda 25.5 : Approval for the proposal of Internet of Things and 5G: Centre of Excellence in Electronics and Communication Engineering Department.

It was submitted to the Academic Council that the department of Electronics and Communication Engineering proposed to form a Centre of Excellence entitled- "Internet of Things and 5G". The following activities have been proposed in the centre:

1. To create research facilities in the area of IOT and 5G.
2. To support UG/PG/Ph.D. students.
3. To encourage sponsored research projects.
4. To organize Seminar, Technical Symposium and conference in the field of IOT and 5G.

The centre will also support, B.Tech, M.Tech and Ph.D students for doing their innovative projects.

The proposed budget for the centre will be INR 4,31,26,800/- with a request to sanction INR 1,80,00,000/- in first year and remaining in the next year. Detailed budget proposal is placed in **Annexure at pages 11 to 14**.

The Academic Council was requested to consider and recommend the proposal of Internet of Things and 5G: Centre of Excellence in Electronics and Communication Engineering Department along with the proposed budget to the Finance Committee for further consideration.

Decision : The Academic Council considered and approved the agenda in principle and requested Prof. S. Indu, Professor, Department of E & C to re-draft the proposal in accordance with the Act, Statutes and Ordinances of the University. The Vice Chancellor is authorised to accept the changes. Thereafter the matter may be placed before the Finance Committee for its consideration.

Agenda 25.6 : Approval for Establishment of Centre of Excellence for Research in Unmanned Vehicles (CERUV).

It was submitted to the Academic Council that the HOD, Electronics and Communication Engineering proposed to establish a Centre of Excellence for Research in Unmanned Vehicles. The following Labs are proposed under the centre:-

1. **Bio-Inspired Aerial Vehicles Lab** - Development of UAVs capable of executing infrastructure inspection and maintenance work.
2. **Dynamic Systems Lab** - Development of vehicles capable of doing tasks deemed dangerous to human beings.
3. **Eco-UAV Lab** - Development of UAVs powered by Renewable Sources of Energy.
4. **Counter-drones Technology Lab** - Development of drone detection and anti-drone technologies.

Following are the objectives/benefits of the Centre:

1. To support our country's initiative of "Make in India" by devoting research in the development of indigenous products and become one of the globally reputed centres in Unmanned Vehicles.
2. To strengthen our Armed Forces and make them self- reliant.
3. To provide exposure to the undergraduate students and mould them into 'complete' engineers.
4. To satisfy the 17 Sustainable Development Goals initiated by the United Nations.

5. To run an internship centre during vacations for engineering students of DTU and other institutions.
6. To run certification courses on Unmanned Vehicles for students.
7. To organize seminars, conferences and workshops in the field of Unmanned Vehicles.
8. To organise Faculty Training & Development Programmes.
9. To promote and support start-ups in the field of Unmanned Vehicles.
10. To publish good quality research publications, patents and technology transfer.
11. To offer M.Tech. and Ph.D. programmes in the field of Unmanned Vehicles.

The Academic Council was requested to consider the above proposal for the development of the Centre of Excellence for Research in Unmanned Vehicles (CERUV) by the Department of Electronics and Communication Engineering, DTU. It was also requested that an amount of Rs. 2,69,50,000/- may be considered by the Academic Council, Finance Committee and Board of Management, DTU.

Decision : The Academic Council considered and approved the agenda in principle and advised HOD (ECE) to review the proposal to form guidelines in accordance under the Act, Statues and Ordinances of DTU. The Vice Chancellor is authorised to accept the changes. Thereafter, the matter may be placed before the Finance Committee for its consideration.

Agenda 25.7 : Approval for Foundation Elective - Community Engagement for UG students of the University (for 2 Credits).

It was submitted to the Academic Council that an online meeting of the Advisory Committee held on 12.10.2020. In the meeting it was discussed that in view of the UGC guidelines regarding Fostering Social Responsibility & Community Engagement in Higher Educational Institutions in India- Jan -2020, the DTU may also initiate steps. Prof. Amit Srivastava made detailed presentation in respect of the above guidelines in the meeting.

It was proposed to start the new foundation elective course Community Engagement of 2 Credits as per the UGC Guidelines on Fostering Social Responsibility & Community Engagement in Higher Educational Institutions in India for UG Students. It can be taken by any student of 1st or 2nd year of B. Tech having two credits and other UG programmes.

Hence, the agenda for approval of Academic Council was proposed as below:

Subject Code	
Subject Name	Community Engagement (Syllabus placed opposite)
Contact Hours	02 hrs per week
Examination Duration	2 hrs
Credit	02
Semester	I to IV
Subject Area	This course will enable students to learn about rural challenges and develop understanding of rural wisdom and life-style in a respectful manner.
Pre-requisite	NIL
Objective	I. To develop an appreciation of rural culture, life-style and wisdom amongst students II. To learn about the status of various agricultural and rural development programmes III. To understand causes for rural distress and poverty and explore solutions for the same IV. To apply classroom knowledge of courses to field realities and thereby improve quality of learning

Decision : The Academic Council considered and approved Foundation Elective - Community Engagement for 1st and 2nd year B.Tech students of the University (for 2 credits) with changed nomenclature "Fostering Social Responsibility and community engagement".

Agenda 25.8 : Approval for amendment/ addition in the Regulations of Ph.D. Ordinance, 2017.

It was submitted to the Academic Council that the Dean, Academic (PG) has proposed some amendment/addition in the Regulations of Ph.D. Ordinances, 2017. The Academic Council suggested some changes in the proposed Regulations which have been incorporated as under:

Regulation	Present	Amendment/Revised
R.3.1(C)	Screening Test shall be waived only for UGC/CSIR/DST/JRF fellowship holders, foreign students who apply through MHRD, Foreign students under cultural exchange scholarship programme (ICCR), Govt. of India.	Screening Test shall be waived for UGC/CSIR/DST/ DBT/ICMR/IARI -JRF fellowship holders, all foreign national students including those sponsored by ICCR/MHRD/MEA, and covered under MoU with Delhi Technological University and Faculty of the Delhi Technological University. Moreover, Vice Chancellor may accord exemption from screening test to the Academic/Non-Teaching staff of the Delhi Technological University and the officers of Govt. of India/Govt. of NCT of Delhi, considering the merit of each case. Such candidates shall have an experience of 15 years, age should not be less than 45 years and will be registered as Part Time candidate without DTU fellowship.
R.19(i)	The academic staff of the Delhi Technological University (including the academic staff of erstwhile Delhi College of Engineering)-Full Fee Waiver.	The teaching/non-teaching/ academic staff of the Delhi Technological University (including the teaching/non-teaching/ academic staff of erstwhile Delhi College of Engineering) and officers of Department of Technical and Higher Education, Govt. of NCT of Delhi -Full Fee Waiver.
R.7.2(e)	-	The Ph.D. slot of the supervisor will be counted from the date of admission of the concerned

		research scholar. Once a registered Ph.D. candidate submits his/her Ph.D. thesis, it will be presumed that a slot vacancy has been created and is available for admission of a fresh research scholar under that supervisor.
R.7.2(f)	-	If a faculty is supervising any research scholar as a Joint Supervisor of any other University/Institution , that will be counted over and above towards the slot quota of the Supervisor. A faculty can jointly supervise at the most 02 Ph.D. scholars who are not registered in Delhi Technological University.
R.15.2(iii)(a)	-	<p>The authors in the publication should only be the Ph.D. Student and Supervisors/Co-Supervisors.</p> <p>External co-author(s), if required, from Research Agencies, Foreign Universities and other reputed Universities/Institutions/Laboratories can be a co-author(s), provided due permission is taken from DRC concerned and No Objection certificate (NOC) is obtained from the external co-author(s) for inclusion of the paper in the thesis of Ph.D. student.</p> <p>An undertaking should be obtained from the external author(s) and Ph.D. student wherein it should be mentioned that the publication is not included as a part of any other award of degree/diploma.</p>
R.1.2	Part-time applicants will be eligible under three categories (i) Candidates from organizations which have MOU with Delhi Technological University (ii) Organizations with	Part-time applicants will be eligible under four categories (i) Candidates from organizations which have MOU with Delhi Technological University (ii) Organizations with R&D Labs of national repute (iii) Regular

<p>R&D Labs of national repute (iii) Regular faculty/Teaching cum Research Fellow or Scientists from Educational Institutions, R&D Organizations, and Govt. Department/Govt. Undertaking provided that the applicant possesses the minimum entry qualifications for the degree as given in R 1.1; the applicant is in position to complete mandatory course requirements along with regular counterparts; the applicant proves to the satisfaction of the University that his official duties permits him to devote sufficient time to research; facilities for research are available at the applicant's place of work in the chosen field of research or the applicant can spare sufficient time to pursue research in the Department of the Delhi Technological University on daily; residing in the vicinity of the University; and he will be required to reside at the Delhi Technological University for a period of not less than 06 months during his admission period for the Ph.D. programme. (This condition of minimum residence will be automatically waived for candidates who are working in National Capital Region (NCR) of Delhi or in organizations/institutions located within a distance of 50 km from the Delhi Technological University).</p>	<p>faculty/Teaching cum Research Fellow or Scientists from Educational Institutions, R&D Organizations, Govt. Departments/Govt. Undertakings/Public Sector Undertakings (iv) Candidates from industry of high repute and a medium sized enterprises with turnover Rs. 75 crores or above along with standing commitment to the exemplary standards namely ISO/CMM level 3 or similar standard of respective area; provided that the applicant possesses the minimum entry qualifications for the degree as given in R 1.1; the applicant is in position to complete mandatory course requirements along with regular counterparts; the applicant proves to the satisfaction of the University that his official duties permits him to devote sufficient time to research; facilities for research are available at the applicant's place of work in the chosen field of research or the applicant can spare sufficient time to pursue research in the Department of the Delhi Technological University on daily; residing in the vicinity of the University; and he will be required to reside at the Delhi Technological University for a period of not less than 06 months during his admission period for the Ph.D. programme. (This condition of minimum residence will be automatically waived for candidates who are working in National Capital Region (NCR) of Delhi or in organizations/institutions located within a distance of 50 km from the Delhi Technological University).</p>
---	---

R.25		Power to remove difficulties: If any difficulty arises in giving effect to the provisions of these regulations, the Vice Chancellor may make such provisions, not inconsistent with the provisions in these regulations, as appear to be necessary or expedient for removing the difficulty.
------	--	--

Decision : The Academic Council considered and recommended the amendment/addition in the Regulations of Ph.D. Ordinance, 2017 after some modifications to the Board of Management for approval. Further, the Council approved that all the International Students and candidate who qualified Department of Biotechnology (DBT) and Indian Council of Medical Research (ICMR) examinations, be considered for written test waiver.

Agenda 25.9 : Approval for admissions in Ph.D for the students admitted in August, 2020.

It was submitted to the Academic Council that the admissions were made in August 2020 for Ph.D. The list of the admitted students for the different Ph.D programmes was given in Annexure in the agenda note.

Decision : The Academic Council considered and approved the admission and also authorised Vice Chancellor to accept the additions, if any.

Agenda 25.10 : Formal registration of Ph.D. Students upon successful completion of course work and comprehensive examinations and approval of research Plan by respective DRCs.

It was submitted to the Academic Council that Dean Academic (PG) has forwarded a list of **29 candidates** to consider their registration for Ph.D. candidature upon successful completion of course work and comprehensive examinations. List of the candidates (department-wise) is placed below:

Sr. No.	Name of the Candidate	Roll No	Date of SRC
DEPARTMENT OF Applied Chemistry			
1	JagramMeena	2K18/PHD/AC/13	09.07.2020
DEPARTMENT OF Mechanical Engineering			
1	Ashok Kumar Singh	2K18/PHD/ME/533	23.07.2020
2	Neeraj Kumar	2K18/PHD/ME/32	21.08.2020
3	Manoj Kumar	2K18/PHD/ME/31	21.08.2020
4	Ashish Kumar	2K18/PHD/ME/26	23.08.2020
5	Syed Wasiul Hasan Rizvi	2K18/PHD/ME/21	26.08.2020
6	Ranjan Prakash	2K18/PHD/ME/16	17.08.2020
7	Sachin Rana	2K18/PHD/ME/14	21.08.2020
8	Prashant Rathi	2K18/PHD/ME/03	23.08.2020
9	Varsha Pathak	2K18/PHDME/01	28.08.2020
10	Ravi Datt Yadav	2K18/PHDME/511	22.09.2020
11	Bharat Singh Yadav	2K19/PHDME/22	13.10.2020
12	Phool Singh	2K18/PHDME/12	03.08.2020
13	Kalpana Gupta	2K18/PHDME/503	21.07.2020
14	Jayesh Kumar	2K18/PHD/ME/20	05.10.2020
15	Narender	2K18/PHD/ME/19	05.10.2020
DEPARTMENT OF BIOTECHNOLOGY			
1	Sudhanshu Sharma	2K19/PHDBT/04	28.07.2020
Deptt. of Applied Physics			
1	Sanjay	2K13/PHDAP/08	11.06.2015
Deptt. of Applied Mathematics			
1	Pooja Yadav	2K18/PHD/AM/04	27.07.2020
Deptt. of Electrical Engineering			
1	NeevatikaVerma	2K18/PHD/EE/04	15.07.2020
2	AshimaTaneja	2K18/PHD/EE/03	10.07.2020
Deptt. of Environmental Engineering			
1	Ali Raza Noori	2K19/PHD/EN/07	11.08.2020
2	RikiSarma	2K19/PHDEN/01	07.09.2020
Deptt. of Humanities			
1	Pallavi Singh Gautam	2K18/PHDHU/502	22.08.2020

Deptt. of Civil Engineering			
1	Nitin Lamba	2K17/Ph.D./CE/13	05.07.2019
2	Prateek Roshan	2K19/PHDCE/02	28.08.2020
Deptt. of USME			
1	ShivangiVerma	2K18/PHDUSME/501	29.08.2020
Deptt. of DSM			
1	Chandan Sharma	2K18/PHDDSM/06	13.02.2020
2	Elixir Sagar	2K18/PHDDSM/02	06.07.2020

Decision : The Academic Council considered and approved formal registration of 29 candidates and confer their candidacy for Ph.D. program.

Agenda 25.11 : Cancellation/Withdrawal of admissions made during July 2020 to September 2020 for Ph.D. programme.

It was submitted to the Academic Council that the certain admissions have been withdrawn during July 2020 to September 2020 for Ph.D programme. The list of the students who cancelled their registration is given below:

Sr. No.	Name of the Candidate	Roll No	Name of the Department
1	Mr. Yogesh	2K17/Ph.D./CE/18	Civil Engineering
2	Abhishek Srivastava	2K18/PHDCE/04	Civil Engineering
3	Pankaj Kumar	2K19/PHDAM/01	Applied Mathematics
4	Sanjeev Srivastava	2K18/Ph.D./AM/06	Applied Mathematics
5.	Mr. Nagesh Kumar Srivastava	2K18/PHDME/521	Mechanical Engineering
6.	DhruvGoel	2K19/Ph.D./AM/08	Applied Mathematics

Decision : The Academic Council considered and approved Cancellation/ Withdrawal of admissions made during July 2020 to September 2020 for Ph.D. programme.

Agenda 25.12 : To consider the recommendation of committee on converting the core courses of final year into elective courses and provision of Minor in B.Tech Program in pursuance with the Ordinance 1(B), 2018 for all B.Tech programmes of the university.

It was submitted to the Academic Council that the inter disciplinary nature of engineering education is becoming more pronounced with new technologies, like, AI, Robotics, Machine Learning, Embedded Systems, IOT and Electric Vehicles, Geo-Informatics, Renewable Energy Systems etc. A graduate confined to his/her own discipline may find it very difficult to tackle the real life modern engineering problems. The Universities world-wide have started addressing these issues in various ways such as Semester long CAPSTONE projects and/or industrial internship, providing options for Minor along with the discipline to which the students is admitted. New Education Policy also emphasises on the inclusion of Minor along with the degree.

The existing choice-based-credit-system (CBCS) oriented schemes of teaching and examination of B.Tech programmes was implemented w.e.f. AY 2016-17. Under the current teaching and examination schemes of B.Tech programmes, a student has to earn total 171 credits (2018 onwards) for award of degree as per the following details:

S. No.	Type of Course	Credits
1.	Foundation Core course	36
	Foundation Elective	8
2.	Departmental core courses	78 to 82
3.	Humanities, social sciences and Management courses	06
4.	Allied Engineering courses	08
5.	Department Electives (DEC)/Open Electives (OEC)/Generic Electives (GEC)	31 to 35 (8 to 9 elective Courses)
	Total Credits	171

In view of above a committee was constituted by competent authority of university vide order No. DTU/Reg/OO/2019-21/743 dated 21.08.2020 to frame the guidelines for shifting of core courses from final year, running of Minor by different departments and to transfer/inclusion of course credits for short term/specialization courses organized by foreign Faculty.

The committee discussed and deliberated on the subject matter at length and was of the view that the CBCS is a perfect platform on which the Minor can be offered to the students through minimal changes in the existing schemes of teaching and examination. The Committee unanimously recommended the following:

1. Conversion of Core Courses of 7th and 8th semesters to Elective Courses:

- All the core courses currently being offered by various disciplines in 7th and 8th semesters may be converted into departmental elective courses (DECs).
- As per existing scheme, a student is allowed to choose electives of other departments against his/her DECs which are termed as GECs. Thus these GECs are equivalent to open elective course (OEC). It is therefore recommended, that the 3 credit open elective course (OEC) in 5th semester is to be converted to a DEC of 4 credits. The syllabi of courses listed against OECs may be reviewed by the Academic departments to make those worth 4 credits. These courses may be merged in the list of DECs of respective disciplines. The total credits to be earned for B. Tech degree will thus enhance from 171 to 172.
- The number of DECs may be increased from existing 8/9 (31 to 35 credits) to 12 (48 credits) uniformly in all the disciplines.
- All the core courses may be accommodated till 6th semester. Further efforts should be made to cover maximum core courses till 5th semester.
- For this a Uniform Scheme is proposed for all B. Tech. Programmes which is as under:

Course Structure for B. Tech. Program (Total Credits 172)

Number of Courses 1 st SEM			Number of Courses 2 nd SEM			Number of Courses 3 rd SEM			Number of Courses 4 th SEM			Total	
A S C	A E C	F E C	AS C	A E C	F E C	D C C	A E C	FEC	D C C	A E C	FE C	ASC/ AEC/ DCC	FEC
3/2	2/3	1	2/3	3/2	1	4	1	1	4	1	1	20	4

Number of Courses 5 th SEM			Number of Courses 6 th SEM			Number of Courses 7 th SEM				Number of Courses 8 th SEM			Total	
D C C	DE C/ GE C	H U / M G	D C C	DEC/ GEC	H U/ M G	D C C	DEC/ GEC	Pr oje ct	Indust rial Traini ng	D C C	DEC / GEC	P r oj ec t	DC C	DE C/ GE C
2	3	1	3	2	1	0	4	1	1	0	3	1	12	12

2. Introduction of Minor

Major and Minor: A major is the discipline to which a student is admitted to obtain his/her degree which is his/her primary field of study. The Minor is a secondary area of study opted by a student which may be either from his /her own discipline or any other discipline. The introduction of Minor will enhance the knowledge base and employability of the students.

Every UG student shall have the option to do a Minor along with his/her major discipline of study. A student who is keen to broaden his/her knowledge in a specific discipline can choose Elective Courses to fulfil the requirements of the Minor offered in that opted discipline.

Alternately, a student may opt a Minor offered by his/her own discipline of study to gain in-depth knowledge in any emerging area of that discipline.

To obtain a Minor in a specific discipline, a student must earn requisite number of credits (courses) from the prescribed basket of courses for that particular Minor. The Minors usually require a certain amount of prerequisite knowledge which a student from other discipline must have acquired by pursuing few core and/or elective courses of the discipline offering Minor.

A Minor shall be awarded to a student along with his/her major discipline if he/she has earned requisite credits (courses) from the prescribed basket of Courses for that Minor.

- A student who wishes to pursue a **Minor from other discipline** must earn 24 credits (out of the total 48 credits to be earned from elective courses) from the basket prescribed for that particular Minor. The remaining 24 credits must be earned from the DEC's of the discipline to which the student is pursuing his/her UG degree.
- A student who wishes to pursue a **Minor from the own discipline** must earn 20 credits (out of the total 48 credits to be earned from elective

courses) from the basket prescribed for a particular Minor. The remaining 28 credits may be earned from the DEC/GECs.

- c. A student not keen to pursue a Minor must earn at least 24 to 28 credits (out of the total 48 credits to be earned from elective courses) from the DEC/GECs of the discipline in which the student is pursuing his/her UG degree. The remaining credits (24 or 20) may be opted from DEC/GECs.
- d. Out of 48 Credits of DEC/GECs, a student may earn 8 credits from the following:
 - (i) **MOOCs**: Provided that the MOOC opted should be relevant to DEC/GEC courses of the University.
 - (ii) **Short Term/specialized Courses** attended within or outside the University like GIAN, SPARC etc. as per the provisions of AC agenda no. 24.11 approved by AC in its 24th meeting held on 29/7/2020.

3. Guidelines for Implementation

- a. The academic departments shall mandatorily offer one MINOR having nomenclature same as their respective discipline(s) only for the students of other discipline. Additionally, every department shall also offer two MINORs in each discipline which shall be open for all students.
- b. Discipline shall prepare basket of courses for each MINOR consisting of core and elective courses pertaining to that MINOR.
- c. Number of prescribed core courses for a MINOR should not exceed three and should be from among the curriculum of B. Tech Program of that discipline. All the core courses prescribed in the basket of a MINOR shall mandatorily be studied and passed by the students opting for that particular MINOR.
- d. A student opting for a MINOR offered by his/her own discipline shall have to earn only 20 credits (5 courses) from the prescribed basket whereas, for obtaining MINOR of disciplines other than his/her own discipline, he/she will have to earn 24 credits (6 courses).
- e. Student desirous of opting a MINOR shall register for the same in 3rd/4th semester of his/her program of study.
- f. Student shall be permitted to register for the courses pertaining to the MINOR opted by him/her as and when they are offered by the respective department (i.e. odd or even semester) during his/her studies.
- g. If a student has already earned credits for a course from some discipline other than the one in the basket of a MINOR, and its syllabus is similar to the course of MINOR then an Equivalence Committee may examine and recommend for counting these credits towards requirement of MINOR. The Constitution of Equivalence Committee shall be (i) HoD's of department offering MINOR; (ii) Head of Department in which student is enrolled; (iii) Coordinator of the course.

- h. Academic departments shall ensure that courses across the MINORs offered by the departments shall not be common/ similar enough so that a student is able to earn two MINORs on the basis of same courses. **A student shall not be allowed to opt for Two MINORs in any case.**
 - i. Academic departments shall offer sufficient number of electives. Normally, Maximum class strength for an elective shall not exceed 75 students. Electives shall be offered to students on first come, first served basis irrespective of his/her discipline.
4. The recommendations of the committee shall be applicable with effect from Academic Year 2020-21 irrespective of year of admission of the student.
5. If approved the provision of Minor may be included in **Regulation R.1(B).11 Course Registration** of Regulation 2018.

The recommendations of the committee were submitted for the consideration by the Academic Council.

Decision : The Academic Council considered and approved the recommendations of committee on converting the core courses of final year into elective courses and provision of Minor in B.Tech Program in pursuance with the Ordinance 1(B), 2018 which will be applicable to all the students from academic year 2019-20 onwards. The Council further recommended the matter to the Board of Management for its approval.

Agenda 25.13 : Conversion of Core Courses of 7th and 8th semesters to Elective Courses.

It was submitted to the Academic Council that all the core courses currently being offered by various disciplines in 7th and 8th semesters to be converted into departmental elective courses (DECs).

- A. As per existing scheme, a student is allowed to choose electives of other departments against his/her DECs which are termed as GECs. Thus these GECs are equivalent to open elective course (OEC). It is therefore recommended, that the 3 credit open elective course (OEC) in 5th semester is to be converted to a DEC of 4 credits. The syllabi of courses listed against OECs may be reviewed by the Academic departments to make those worth 4 credits. These courses may be merged in the list of DECs of respective disciplines. The total credits to be earned for B. Tech degree will thus enhance from 171 to 172.

- B. The number of DEC's may be increased from existing 8/9 (31 to 35 credits) to 12 (48 credits) uniformly in all the disciplines.

The revised Teaching and Examination Schemes for B.Tech programmes were placed in Annexure at page 48 to 176 in the Agenda Note.

Decision : The Academic Council considered and approved the conversion of Core Courses of 7th and 8th semesters to Elective Courses.

Agenda 25.14 : To consider the recommendations of Board of Studies of different Academic Departments with regard to introduction of Minor to be offered by various academic departments.

It was submitted to the Academic Council that each academic department has proposed one MINOR having nomenclature same as their respective discipline(s) only for the students of other disciplines.

Additionally, every department has also proposed 2/3 MINORs in each discipline which shall be open for all students.

The Departmental of Environmental Engineering has proposed some modifications in the minor which have been incorporated and are placed in **Annexure at page 15 to 18**. The proposed MINORs along with their prescribed basket of core and elective courses to be offered in **the remaining departments** were placed in Annexure in the Agenda Note.

Decision: The Academic Council considered and approved the recommendations of Board of Studies of different Academic Departments with regard to introduction of Minor to be offered by various academic departments including department of Applied Chemistry.

Agenda 25.15 : Approval for the introduction of new elective courses in V, VI, VII and VIII semester along with syllabus for various B.Tech programmes at Delhi Technological University.

It was submitted to the Academic Council that the Departments of Electrical Engineering, Information Technology, Electronics and Communication, Civil Engineering, Software Engineering, Computer Engineering, Applied Chemistry and Environmental Engineering convened online Faculty meeting to discuss the introduction of minors. The departments have recommended nomenclature proposed minors.

In view of this, it was submitted to the Academic Council that a structure of Minors with a basket of Core and Elective courses, the scheme and the detailed syllabi of various B. Tech programmes duly approved by their respective Board of Studies were placed as Annexure in the Agenda Note. Since the scheme and detailed syllabus of "Chemical Engineering" were not a part of agenda the same were also considered and approved by the Council during the course of meeting. Accordingly, the scheme and detailed syllabus of "Chemical Engineering" are placed in **Annexure at page 19 to 96**.

Decision : The Academic Council considered and approved for the introduction of new elective courses in V, VI, VII and VIII semester along with syllabi for various B.Tech programmes including B.Tech "Chemical Engineering" programme at Delhi Technological University with minor modifications. Academic Council also advised that Program Objective/Course Objective should be defined properly.

Agenda 25.16 : Academic Calendar for B.Tech first semester (AY 2020-21).

It was submitted to the Academic Council that the academic calendar for B.Tech. 1st Semester (Academic Year-2020-2021) proposed as under for approval:

S.No.	Activity	Date	
1.	Filling of Online Registration	01.12.2020 to 21.12.2020	
2.	Online Orientation Program	02.12.2020 to 04.12.2020	
3.	Teaching Starts	07.12.2020	
4.	Surprise Tests I & II	On any working day without prior information to the Students	
5.	Submission of Proposal of Innovative Work* to the concerned faculty for MTE component for courses having ETE	15.01.2021	
6.	Submission of Proposal of Innovative Practical Work* to the concerned faculty for PRS component for courses having PRE		
7.	Class Test – I & Practical Test – I (On any working day with prior information to the Students)	Between 04-01-2021 & 15-01-2021	Online Submission of Marks (Action: Faculty) 22.01.2021
8.	1 st Review of Innovative Work* for MTE components for courses having MTE	15.02.2021	
9.	1 st Review of Innovative Practical Work* for PRS components for courses having PRE		
10.	Class Test – II & Practical Test – II (On any working day with prior information to the Students)	Between 15-02-2021 & 26-02-2021	Online Submission of Marks : (Action: Faculty) 05.03.2021
11.	Submission & Evaluation of Innovative Work* for MTE component for courses having MTE	Between 08-03-2021	Online Submission of Marks :

12.	Submission & Evaluation of Innovative Practical Work* for PRS component for courses having PRE	& 19-03-2021	(Action: Faculty) 26.03.2021
13.	Class Test – III & Practical Test – III (On any working day with prior information to the Students)	Between 15-03-2021 & 26-03-2021	Online Submission of Marks : (Action: Faculty) 02.04.2021
14.	Teaching Ends		26.03.2021
15.	Online Submission of Marks of All Components of Evaluation		02.04.2021 (Action: Faculty)
16.	Online Submission of Grades to Examination Branch by Course Coordinators		09.04.2021
17.	Declaration of Results		30.04.2021

Decision : The Academic Council considered and approved the Academic Calendar for B.Tech first semester (Academic Year 2020-21) and for B.Tech (Evening) programmes also. The Council further, Authorized Vice Chancellor to accept the proposal of other programmes for 1st year students.

Agenda 25.17 : To consider the recommendations of committee on matter of Dual/Joint professorship in the University.

It was submitted to the Academic Council that a committee consisting of the following members was constituted by the Hon'ble Vice Chancellor to look into the matter of Dual/Joint professorship in the University:

- | | |
|---|--------------|
| 1. Prof. A Trivedi, Dean (IRD) | -Chairperson |
| 2. Prof. Madhusudan Singh, Dean Acad (UG) | - Member |
| 3. Prof. Vishal Verma, Dean (IA) | - Member |
| 4. Prof. Pragati Kumar, EE Department | - Member |

An online meeting of the committee was held on 21.10.2020 at 4.00 PM and deliberated on the issue. The followings were the recommendations of the committee:-

Provision of Joint Professorship in the University

Preamble: With increasing use of Information Technology, Artificial Intelligence, Machine Learning, Data Analytics, Mobile Communication, robotics, electric vehicles (EVs) etc. in various engineering and science disciplines, there is a requirement of trained professionals in every discipline, who have an interdisciplinary mindset and exposure. Taking into account this fact, DTU wants to encourage academic and research activities which demand expertise in different multidisciplinary areas. For this purpose, University may designate suitably qualified professors of the University as **Joint Professors**.

A. Scope and domain of Joint professorship

- i. A small number of eminent professors of the University who can contribute in the interdisciplinary academic/research activities may be offered Joint Professorship.
- ii. Such designated professor shall contribute their expertise in the interdepartmental/interdisciplinary teaching/ research programmes.
- iii. The scope of their activities will be limited within the University only and would not be extended to other universities/institutions.
- iv. The department in which the Professor was initially appointed by the University shall be called the "Parent" department and the department in which he/she is designated as a **Joint Professor** shall be called the "Second" department.

B. Selection of Joint Professors

- i. Joint professorship shall be extended to not more than 10% of the University professors at any given point of time. A number not more than five (05) of Joint professors shall be appointed during one calendar year.
- ii. Applications may be invited from a professor with a standing of **10 Years** as professor, detailing their academic background and the plan of proposed work to be carried out by him/her in both the departments. In addition to the application from individual professors, the Vice-Chancellor/Pro-VC may nominate a professor for consideration of the Joint professorship.
- iii. A committee consisting of the followings will invite a suitably identified person for interaction:
 - a) Vice-Chancellor, Chairman
 - b) Pro-Vice Chancellor, Member
 - c) A Dean nominated by the VC, Member
 - d) Three external experts nominated by the Vice Chancellor
- iv. A professor of the university who meets the following criteria may be considered for joint professorship:
 - a) A Professor with **10 years** of experience in teaching and research.
 - b) At least 10 research publications in SCI/SSCI journals and should have at least 02 successful Ph.D. guided as supervisor/co-supervisor as a professor.
 - c) A professor with good track record of innovative teaching and research.
 - d) At least 2 research publications out of 10 publications specified in B(iv)(b) should be in the relevant area of the discipline of the second department.

C. Tenure of Joint Professorship

- i. The performance of a Joint professor shall be assessed by a committee of three experts appointed by the Vice-Chancellor, after a period of 5 years of appointment and shall recommend for continuation of joint professorship or otherwise.

D. Duties and responsibilities

a) Teaching assignment

A joint professor will take teaching assignment as per the requirements in the Parent and /or Second department as per UGC/AICTE norms in either or both of the departments (parent department & Second department). The host/second Department will pay honorarium at double the rate which is applicable to Professors, in case the joint Professor is assigned extra teaching load.

b) Research assignment

- i. A Joint professor shall be involved in research activity in the parent and second department.
- ii. The possibility of Joint projects with external funding agencies should be explored and implemented wherever possible.

c) Administrative assignments

- i. Administrative work may be assigned to the Joint Professor in the Second department by the Vice-Chancellor.

E. Facilities/privileges of the Joint Professors

- i. Suitable office and laboratory space (if required) shall be provided to the Joint professors in the Second department.
- ii. Joint Professor will have access to all the available resources including library and research facilities.
- iii. A Joint Professor shall be a recognized guide in both the Departments. He/she can register students for Ph.D degree from both the Departments subject to the terms and conditions laid down in Ph.D. ordinance
- iv. A joint professor will have only single voting right in statutory bodies like academic council from the parent department.

F. Power to remove difficulties.

- (i) If any difficulty arises in giving effect to the provisions of these guidelines, the Vice Chancellor may make such provisions, not inconsistent with the provisions in these guidelines, as appear to be necessary or expedient for removing the difficulty.

Recommendations of the committee were submitted for the consideration by the Academic Council.

Decision: The Academic Council advised that the proposal may be sent to the all Head of the Departments for feedback of the faculty and to submit their comments to the Committee. Thereafter modified recommendations of the Committee may be placed before the Academic Council in next meeting.

Agenda 25.18 : Approval for change of the 2 courses slot from DEC 7 to 8 and vice versa due to offering the MINOR Degree in B. Tech. Program.

It was submitted to the Academic Council that the Dean, Academic (UG) proposed certain changes in the subject name due to offering the MINOR Degree in B.Tech program in the B.Tech Regulations. Following were the proposed changes for approval of the Academic Council:

Existing		
ME- 412	OPERATIONS AND MANUFACTURING STRATEGY	DEC-7 VIII SEM
ME- 418	SUPPLY CHAIN MANAGEMENT	DEC-8 VIII SEM
Revised		
ME- 412	SUPPLY CHAIN MANAGEMENT	DEC-7 VIII SEM
ME- 418	OPERATIONS AND MANUFACTURING STRATEGY	DEC-8 VIII SEM

Decision: The Academic Council considered and approved the proposed change of the course slot due to offering the MINOR Degree in B. Tech. Program.

Agenda 25.19 : Approval for addition the course due to offering the MINOR Degree in B. Tech. Program.

It was submitted to the Academic Council that the Dean, Academic (UG) proposed for addition of following course due to offering the MINOR Degree in B.Tech program for approval of the Academic Council:

Addition		
ME-422	FUEL CELL	DEC-8 VIII SEM

Decision: The Academic Council considered and approved for addition the course due to offering the MINOR Degree in B. Tech. Program.

Agenda 25.20 : Confirmation of admissions of UG students admitted in Academic Year 2019-20 along with their upgraded/allotted disciplines for the consideration of Academic Council.

It was submitted to the Academic Council that following are the number of admissions of UG students admitted in academic year 2019-20 along with their upgraded/allotted disciplines. List of such students were placed in Annexure in Agenda Note.

- (a) B.Tech. – 2281 students
- (b) B.Des – 64 students
- (c) BBA – 122 students
- (d) BAE – 136 students

Decision : The Academic Council considered and approved the admissions of all UG admission for academic year 2019-20 along with their upgraded/allotted disciplines as per the list.

Agenda 25.21 : Approval for enhancement of intake of students in MBA, BBA and B.A. (Economics) programmes in USME.

It was submitted to the Academic Council that Department of Management, East Delhi Campus proposed to enhance the intake of students in various programmes as below for approval of the Academic Council:

Programmes	Present Intake	Proposed Intake
MBA (General)	75	120
BBA	150	180
BA (Economics)	150	180

Decision : The Academic Council considered and approved for enhancement of intake of students in MBA, BBA and B.A. (Economics) programmes from the academic year 2020-21 in the University School of Management and Entrepreneurship.

Agenda 25.22 : To consider the proposal of conferment of degrees on the students who have successfully completed the requirements prescribed under the ordinances of the University.

It was submitted to the Academic Council that a proposal for conferment of degrees on the students who have successfully completed the requirements prescribed under the Ordinances of the University submitted by the Examination Branch. The programme-wise number of eligible students till date is as follows:

Year :2020

S.no	Program	Total Degrees
1.	Bachelor of Technology	1783
2.	Bachelor of Technology (Evening)	96
3.	Bachelor of Arts (Hons.) Economics	87
4.	Bachelor of Business Administration	92
5.	Master of Technology	176
6.	Master of Technology (Part Time)	18
7.	Master of Business Administration	167
8.	Master of Business Administration (Executive)	42
9.	Master of Business Administration (Business Analytics)	27
10.	Doctor of Philosophy	61
	Total	2549

Decision: The Academic Council considered and recommended the proposal of conferment of degrees on the students who have successfully completed the requirements to the Board of Management for its approval. The Council also authorized Vice Chancellor to accept the additions in the list, if any.

Agenda 25.23 : Approval for change of name of existing AICTE approved M.Tech Programme in Nano Science and Technology, M.Tech (NST) running in the Department of Applied Physics to M.Tech in Material Science and Technology.

It was submitted to the Academic Council that the Department of Applied Physics is one of the large departments of Delhi Technological University providing cutting edge research, innovation and education in the emerging areas of science and technology. Presently, the department is offering a UG (B.Tech, Engineering Physics) programme and two PG programs (M.Sc. Physics and M.Tech NST). The Department initiated a specialized PG programme in Nano Science and Technology in the year 2009 with an aim to produce trained professionals in the area of nanotechnology with a sanctioned strength of 20 students. In its early years, the programme was quite popular among graduating students and various scientists and engineers working in various government agencies. However, it has been found that the PG programme is losing its popularity among students, leading to lesser number of students opting for it in the last 2-3 years. One of the possible reasons for this may be the limited scope and span of the subject along with the available market opportunities available in the very specialized field of nanotechnology under the wider canvas of materials sciences. In this regard, we have carried out a survey and found that most of the institute of eminence and universities are offering program in the area of Materials Science, which includes Nano Science and Technology. Therefore, we hereby propose to change the name of our PG program from "M.Tech in Nano Science and Technology" to "M.Tech in **Materials Science and Technology**".

We request you to kindly consider our proposal for approval so that we can increase the scope for students similar to what other institutes are offering.

Decision : The Academic Council considered and recommended for change of name of existing AICTE approved M.Tech programme in Nano Science and Technology, M.Tech (NST) running in the Department of Applied Physics to M.Tech in Material Science and Engineering to the Board of Management for its approval.

Agenda 25.24 : To consider and approve the recommendation of Board of Studies for introduction of additional new DEC's proposed in B.Tech. (EP) and minor correction in the name of courses being offered by Department of Applied Physics.

It was submitted to the Academic Council that a meeting of Board of Studies of the Department of Applied Physics was held with due notice, on 23rd October, 2020 via ONLINE mode to propose the additional courses/ DEC's proposed in B.Tech. (EP) program. Based on the approval of Board of Studies of Applied Physics Department, the following points were proposed as agenda for consideration of Academic Council in the meeting.

B.Tech, (EP) new DEC's to be offered: Syllabus and semester structure

The objectives of introducing the DEC's are as follows:

- i. To equip students with the fundamentals related to engineering materials, placing particular emphasis on advanced materials, design, manufacturing and processes.
- ii. To enable students to be more aware of the behaviour of materials in engineering applications.

To enrich the basket of department elective courses in line with the emerging areas in B.Tech. program, the revised list of DEC's along with new courses (in bold font) along with the scheme is placed below for approval. The detailed syllabus for proposed DEC's is placed in **Annexure at pages 97 to 109**.

Decision: The Academic Council considered and approved the recommendations of Board of Studies for introduction of additional new DEC's proposed in B.Tech. (EP) and minor correction in the name of courses being offered by Department of Applied Physics.



Agenda 25.25 : Approval of Delhi Technological University Logo the Flag.

It was submitted to the Academic Council that the Delhi Technological University was established in 1941 as Delhi Polytechnic by the Government of India and became Delhi College of Engineering in 1965. Delhi College of Engineering became Delhi Technological University in 2009 by Government of NCT of Delhi.

DTU has a University Logo which has already been approved in first meeting of Board of Management held on 26.9.2009.

DTU is also having University Flag of the following specifications since inception of the University. The details of specifications of DTU Logo and Flag are given as: -

1. University LOGO: All text, lines & border are Maroon/Red in colour



2. University FLAG

- (i) Size : 900mm x 600mm or ratio of the length to the height (width) of flag as 3:2 showing DTU Logo.
- (ii) Colour : Maroon.
- (iii) Logo of the University at the centre of Flag encircled with golden strip.



Decision: The Academic Council considered and recommended the LOGO and the Flag of the Delhi Technological University to the Board of Management for consideration and approval.

Agenda 25.26 : Reimbursement of Rs.2000/- per student per semester for internet charges for online classes.

It was submitted to the Academic Council that the physical classes for all the students are held-up due to the current COVID-19 pandemic situation. Studies in the University are being conducted online and all students for both UG and PG programmes are bearing additional internet charges for attending online classes from their respective homes.

The University proposed to reimburse Rs.2000/- (Rupees Two Thousand only) per student to each and every student per semester in order to bear additional internet charges. In case the current situation prevails, this facility shall be extended to subsequent semesters. The expenditure will be incurred from the Students' Welfare Fund.

Decision : The Academic Council considered and recommended for Reimbursement Rs. 2000/- per student per semester for internet charges for online classes to the Finance Committee for further consideration.

Agenda 25.27 : Approval for minor degree in the discipline of Economics and English, Department of Humanities.

It was submitted to the Academic Council that the department of Humanities proposed the following list of elective papers for the Minor Degree for the kind perusal and approval of the Academic Council.

Following was the list elective papers:

1. Minor in Economics

Core Course	Elective Course		
	S.No.	Course Code	Paper
None	1	HU 206	Microeconomics
	2	HU 305	Macroeconomics
	3	HU 306	Money, Banking and Finance
	4	HU 307	Basic Econometrics
	5	HU 308	Mathematical Economics
	6	HU 309	Indian Economy
	7	HU 310	International Trade
	8	HU 405	Economic Growth
	9	HU 406	Public Finance and Policy
	10	HU 407	Wealth and Poverty of Nations- Indian Economic Development

2. Minor in English

Core Course	Elective Course		
	S.No.	Course Code	Paper
None	1	HU 225	Basic Communication Skills
	2	HU 226	Professional Writing Skills
	3	HU 325	Creative Writing Skills
	4	HU 326	Rhetoric and Public Speaking
	5	HU 327	Non-Verbal Communication
	6	HU 328	Theatre and stagecraft
	7	HU 425	Soft Skills Development
	8	HU 426	Language and Social Media
	9	HU 427	Literary Appreciation
	10	HU 428	Adaptation and Translation
	11	HU 429	Advanced Spoken Skills

The detailed syllabus was placed in **Annexure in the Agenda Note.**

Decision : The Academic Council considered and approved for minor degree in the discipline of Economics and English, Department of Humanities along with proposed syllabus.

Agenda 25.28 : Matter for Ratification.

- i. The result of the Intermediate semester students of Even semester of Academic Year 2019-2020 were declared as per the guidelines approved by the Academic Council.
- ii. The guidelines approved by the Academic Council regarding the Evaluation of the students in the ODD semester of Academic year-2020-2021 has been implemented.
- iii. **Grade Award Criteria while evaluating the M.Sc. Dissertation/Project of final year.**

It was submitted to the Academic Council that Competent Authority approved the Grade Award Criteria to be followed by the academic departments while evaluating the M.Sc. Dissertation/Project of final year as below:

Grade	Conditions to be fulfilled
O or A+	One paper accepted/published in SCI.SCI Expanded/SSCI/Scopus indexed journal and on the basis of performance during the viva voce.
A+ or A	One goof quality full-length papers accepted/published in peer reviewed Scopus indexed conferences and on the basis of performance during the viva voce.
B+/B/C/P/F	On the basis of performance during the viva voce.

iv. Fee concession for students belonging to economically weaker sections.

It was submitted to the Academic Council that as per the policy in vogue, any student who availed fee concession in 1st year will continue to be eligible for fee concession in 2nd year, similarly student availing fee concession in 3rd year will continue to be eligible for the same in 4th year also. Due to COVID-19 pandemic and prevailing situation in this academic year, the students who availed fee concession in of 2nd year (AY 2019-20) were also given fee concession in 3rd year (AY 2020-21).

The Academic Council ratified the above four actions of the University.


Agenda 25.29 : Any other matter with the permission of the Chair.

Following matter was also discussed.

Prof. Pragati Kumar from Electrical Engineering Department brought a proposal for reservation of two seats in the University for Police and Paramilitary personals encountered/killed in anti-terrorism and insurgent activities.


Decision : The Academic Council advised that a comprehensive agenda comprising of all possibilities may be prepared and be placed before the Academic Council in its next meeting.

The meeting ended with a vote of thanks to all the members and special invitees.


(Prof. Samsher)
Registrar

Copy to:

1. Pr. Secretary to Hon'ble Lt. Governor (Delhi), 6, Raj Niwas, Civil Lines, Delhi.
2. PA to V.C. for kind information of the Vice Chancellor, DTU.
3. All Deans, DTU.
4. Prof. J.P. Saini, Vice Chancellor, Netaji Subhash University of Technology, Sector 3, Dwarka, Delhi 110078
5. Prof. B.R. Chahar, Professor, Civil Engineering, Indian Institute of Technology, Delhi 110016
6. Prof. Surendra S. Yadav, Professor of Management, Indian Institute of Technology, Hauz Khas, Delhi 110016.
7. Prof. Smriti Srivastava, Head-Division of ICE, Netaji Subhash University of Technology, Sector 3, Dwarka, Delhi 110078.
8. Prof. Tarun Kumar Das, Professor of Mathematics & Ex-Registrar, University of Delhi
9. All Heads of Department, DTU.
10. Prof. Reeta Wattal, Professor, Mechanical Engineering Department
11. Prof. V.K. Minocha, Professor, Civil Engineering Department
12. Sh. Rajesh Birok., Associate Professor, Electronics and Communication
13. Dr. M. Jayasimhadri, Assistant Prof., Applied Physics Department.
14. Controller of Examinations.
15. Registrar, DTU


(Prof. Samsher)
Registrar

ANNEXURE
For
Minutes

25th meeting of
Academic Council
DTU

04-11-2020



DELHI TECHNOLOGICAL UNIVERSITY

Established by Govt. of Delhi vide Act 6 of 2009

(Formerly Delhi College of Engineering)

SHAHBAD DAULATPUR, BAWANA ROAD, DELHI-110042

PAY SCALE, ESSENTIAL QUALIFICATIONS, RELEVANT BRANCH, AGE LIMIT AND RELAXATIONS FOR THE POST OF PROFESSOR IN THE DISCIPLINE OF MANAGEMENT

Designation, Pay Matrix Level & Entry Pay	Essential Qualifications and Experience	Relevant Branch	Age Limit
Professor Level-14 Entry Pay - 1,44,200	<p>'A'</p> <p>Essential Qualifications:-</p> <p>I. First class or equivalent in Master's degree in Business Management/ Administration in a relevant management related discipline or first class in Two year full time PGDM declared equivalent by AIU/Accredited by the AICTE/UGC.</p> <p>'OR'</p> <p>First class or equivalent in M.Tech./Master's Degree in relevant branch.</p> <p>'OR'</p> <p>First class or equivalent Graduate and professionally qualified Chartered Accountant/ Cost & Works Accountant/Company Secretary of the concerned statutory bodies.</p> <p>II. Qualifications as above with Ph.D. or equivalent, in relevant branch.</p> <p>III. At least total 6 research publications at the level of Associate Professor in SCI journals/ UGC/AICTE approved list journals and at least 2 successful Ph.D. guided as Supervisor/Co-supervisor.</p> <p>'OR'</p> <p>At least 10 research publications at the level of Associate Professor in SCI journals/ UGC/ AICTE approved list journals.</p>	<p>Account & Finance, Accountancy, Accounts, Agricultural Economics & Business Management, Banking & Insurance, Business Administration, Business Analytics, Business Data Analytics, Business Economics, Business Law, Business Management, Business Policy & Strategic Management, Commerce, Computer Aided Management, Computer Applications, Computer Engineering & Applications, Computer Engineering, Computer Science & Engineering, Computer Science & Information Technology, Computer Science & Technology,</p>	<p>55 years</p> <p>'Relaxations'</p> <ol style="list-style-type: none"> 1. The age is relaxable for SC/ST candidates upto 5 years and for OBC candidates upto 3 years in respect of vacancies reserved for them respectively. 2. Relaxable for Government Servants upto 5 years in accordance with the instructions or orders issued by the Central Government 3. Relaxable for teachers of government funded institutions of higher education for 5 years. 4. Age relaxable for the PWD category candidates in accordance with the instruction/ orders issued by the central government /GNCT from time to time

	<p>Experience:- A minimum of 10 years of experience in teaching /research /industry out of which at least 3 years shall at the post equivalent to that of an Associate Professor.</p> <p>In case of research experience, good academic record and books/research paper publications/IPR/ patents record shall be required as deemed fit by the expert members of the selection committee.</p> <p>If the experience in industry is considered, the same shall be at managerial level equivalent to Associate Professor with active participation record in devising/designing, planning, executing, analyzing, quality control, innovating, training, technical books/ research paper publications/IPR/patents. etc., as deemed fit by the expert members of the Selection committee</p> <p style="text-align: center;">‘OR’</p> <p>‘B’</p> <p>I. i) An eminent scholar having a Ph.D. degree in the concerned/allied/relevant discipline, and published work of high quality, actively engaged in research with evidence of published work with, a minimum of 10 research publications in the peer-reviewed or UGC-listed journals and a total research score of 120 as per the criteria given in Appendix II, Table 2 of UGC Notification dated 18th July,2018</p> <p>ii) A Master's Degree with at least 55% marks (or an equivalent grade in a point-scale, wherever the grading system is followed).</p> <p>iii) A minimum of ten years of experience in teaching/ research/ industry out of which at least three years shall be at the post equivalent to that of an Associate Professor.</p>	<p>Computer Science and Systems Engineering, Computer Science, Computer Technology & Applications, Computer Technology, Data Analytics, Data Science, Decision Science, E Commerce, Economics, Engineering Management, Finance & Control, Finance, Financial Management, Financial Markets, Global Business Operation, Human Resource Development, Human Resource Management, Industrial Engineering, Industrial Management, Information System, Information Technology & Engineering, Information Technology, International Business, Knowledge Engineering, Knowledge Management, Knowledge Science, Management Science, Marketing Management, Operations Research, Organizational Development, Personal Management & Industrial Relation, Psychology,</p>	
--	--	--	--

	<p style="text-align: center;">OR</p> <p>2. An outstanding professional, having a Ph.D. degree in the relevant/allied/applied disciplines, from any academic institutions (not included in 1. above) / industry, who has made significant contribution to the knowledge in the concerned/allied/relevant discipline, supported by documentary evidence provided he/she has ten years* experience.</p>	<p>Quality Engineering & Management, Sales & Marketing Management, Software Engineering, Software Systems, Software Technology, Statistics, Strategic Management, Technology Management Family Business & Entrepreneurship Innovation, Entrepreneurship & Venture Development</p>	
--	---	---	--

Notes :

1. Any deviation in the nomenclature of the relevant branches as mentioned above may also be considered by the University.
2. AMIE/IETE qualifications in relevant branches mentioned in the RR are also eligible.
3. B.Sc. (Engineering), B.E., B.Tech, B.S. (Four years) shall be considered as equivalent.
4. M.Sc. (Engineering), M.E., M.Tech, M.S. shall be considered as equivalent.
5. Selection Committee, may in cases of exceptional merit, recommend additional increments in case of higher qualifications, experience and academic achievements by the candidates.
6. Persons already in employment in Government Department/Autonomous Bodies/Universities under Central/State Government should apply through proper channel.
7. If a class/division is not awarded, minimum of 60% marks in aggregate shall be considered equivalent to first class/division. If conversion formula for CGPA to percentage marks is not given/defined, CGPA will be converted into equivalent marks by multiplying the CGPA by a factor of 10.



DELHI TECHNOLOGICAL UNIVERSITY

Established by Govt. of Delhi vide Act 6 of 2009

(Formerly Delhi College of Engineering)

SHAHBAD DAULATPUR, BAWANA ROAD, DELHI-110042

PAY SCALE, ESSENTIAL QUALIFICATIONS, RELEVANT BRANCH, AGE LIMIT AND RELAXATIONS FOR THE POST OF ASSOCIATE PROFESSOR IN THE DISCIPLINE OF MANAGEMENT

Designation, Pay Matrix Level & Entry Pay	Essential Qualifications and Experience	Relevant Branch	Age Limit
Associate Professor Level-13 A1 Entry Pay - 1,31,400	<p>'A'</p> <p>Essential Qualifications:-</p> <p>I. First class or equivalent Master's degree in Business Management/ Administration in a relevant management related discipline or first class in Two year full time PGDM declared equivalent by AIU/Accredited by the AICTE/UGC.</p> <p>'OR'</p> <p>First class or equivalent in M.Tech./Master's Degree in relevant branch.</p> <p>'OR'</p> <p>First class Graduate and professionally qualified Chartered Accountant/Cost & Works Accountant/Company Secretary of the concerned statutory bodies.</p> <p>II. Qualifications as above with PhD or equivalent, in relevant branch.</p> <p>III. At least total 6 research publications in SCI journals/UGC/AICTE approved list journals.</p>	<p>Account & Finance, Accountancy, Accounts, Agricultural Economics & Business Management, Banking & Insurance, Business Administration, Business Analytics, Business Data Analytics, Business Economics, Business Law, Business Management, Business Policy & Strategic Management, Commerce, Computer Aided Management, Computer Applications, Computer Engineering & Applications, Computer Engineering, Computer Science & Engineering, Computer Science & Information Technology, Computer Science & Technology, Computer Science and Systems Engineering, Computer Science, Computer Technology & Applications,</p>	<p>50 years</p> <p>*Relaxations*</p> <ol style="list-style-type: none"> 1. The age is relaxable for SC/ST candidates upto 5 years and for OBC candidates upto 3 years in respect of vacancies reserved for them respectively. 2. Relaxable for Government Servants upto 5 years in accordance with the instructions or orders issued by the Central Government 3. Relaxable for teachers of government funded institutions of higher education for 5 years. 4. Age relaxable for the PWD category candidates in accordance with the instruction/ orders issued by the central government /GNCT from time to time.

Experience:-

A minimum of 8 years of experience of teaching and /or research in an academic /research position equivalent to that of Assistant Professor in a University/ College / accredited research institutions/ industry out of which at least 2 years shall be post Ph.D. experience.

In case of research experience, good academic record and books/research paper publications/ IPR/patents record shall be required as deemed fit by the expert members of the selection committee.

If the experience in industry is considered, the same shall be at managerial level equivalent to Assistant Professor with active participation record in devising/ designing, planning, executing, analyzing, quality control, innovating, training, technical books/research paper publications/ IPR/ patents, etc., as deemed fit by the expert members of the Selection committee.

'OR'

'B'

- i) A good academic record, with a Ph.D. Degree in the concerned/allied/relevant disciplines.
- ii) A Master's Degree with at least 55% marks (or an equivalent grade in a point-scale, wherever the grading system is followed).
- iii) A minimum of eight years of experience of teaching and / or research in an academic/ research position equivalent to that of Assistant Professor in a University, College or Accredited Research Institution/industry out of which at least two years shall be post Ph.D. experience with

Computer Technology,
Data Analytics,
Data Science,
Decision Science,
E Commerce,
Economics,
Engineering Management,
Finance & Control,
Finance,
Financial
Management,
Financial Markets,
Global Business
Operation,
Human Resource
Development,
Human Resource
Management,
Industrial Engineering,
Industrial Management,
Information System,
Information Technology &
Engineering,
Information Technology,
International Business,
Knowledge Engineering,
Knowledge Management,
Knowledge Science,
Management Science,
Marketing Management,
Operations Research,
Organizational
Development,
Personal Management &
Industrial Relation,
Psychology,
Quality Engineering &
Management,
Sales & Marketing
Management,
Software Engineering,
Software Systems,
Software Technology,
Statistics,
Strategic Management,
Technology Management
Family Business &
Entrepreneurship

	a minimum of seven publications in the peer-reviewed or UGC-listed journals and a total research score of Seventy Five (75) as per the criteria given in Appendix II, Table 2 of UGC Notification dated 18 th July, 2018.	Innovation, Entrepreneurship & Venture Development	
--	--	--	--

Notes.:

1. Any deviation in the nomenclature of the relevant branches as mentioned above may also be considered by the University.
2. AMIE/IETE qualifications in relevant branches mentioned in the RR are also eligible.
3. B.Sc. (Engineering), B.E., B.Tech, B.S. (Four years) shall be considered as equivalent.
4. M.Sc. (Engineering), M.E., M.Tech, M.S. shall be considered as equivalent.
5. Selection Committee, may in cases of exceptional merit, recommend additional increments in case of higher qualifications, experience and academic achievements by the candidates.
6. Persons already in employment in Government Department/Autonomous Bodies/Universities under Central/State Government should apply through proper channel.
7. If a class/division is not awarded, minimum of 60% marks in aggregate shall be considered equivalent to first class/division. If conversion formula for CGPA to percentage marks is not given/defined, CGPA will be converted into equivalent marks by multiplying the CGPA by a factor of 10.



DELHI TECHNOLOGICAL UNIVERSITY
Established by Govt. of Delhi vide Act 6 of 2009
(FORMERLY DELHI COLLEGE OF ENGINEERING)
BAWANA ROAD, DELHI-110042

PAY SCALE, ESSENTIAL QUALIFICATIONS, RELEVANT BRANCH, AGE LIMIT AND RELAXATIONS FOR THE POST OF ASSISTANT PROFESSOR IN THE DISCIPLINE OF MANAGEMENT

Designation, Pay Matrix Level & Entry Pay	Essential Qualifications and Experience	Relevant Branch	Age Limit
Assistant Professor Level-10 Entry Pay - 57,700/-	<p>'A'</p> <p>(I) First class Master's degree in Business Management/ Administration or first class in Two year full time PGDM declared equivalent AIU/ Accredited by the AICTE/UGC.</p> <p style="text-align: center;">'OR'</p> <p>First class in M.Tech./M.E. in relevant branch.</p> <p style="text-align: center;">'OR'</p> <p>First class Master's degree in relevant branch.</p> <p style="text-align: center;">'OR'</p> <p>First class Graduate and professionally qualified Chartered Accountant/ Cost & Works Accountant/ Company Secretary of the concerned statutory bodies.</p> <p>(II) Two years of professional experience after acquiring the above mentioned degrees of Master's degree.</p> <p style="text-align: center;">'OR'</p> <p>'B'</p> <p>I (i) A Master Degree with 55% marks (or and equivalent grade in a point-scale wherever the</p>	<p>Account & Finance, Accountancy, Accounts, Agricultural Economics & Business Management, Banking & Insurance, Business Administration, Business Analytics, Business Data Analytics, Business Economics, Business Law, Business Management, Business Policy & Strategic Management, Commerce, Computer Aided Management, Computer Applications, Computer Engineering & Applications, Computer Engineering, Computer Science & Engineering, Computer Science & Information Technology, Computer Science & Technology, Computer Science and Systems Engineering, Computer Science, Computer Technology & Applications, Computer Technology, Data Analytics, Data Science, Decision Science, E Commerce, Economics, Engineering Management, Finance & Control,</p>	<p>35 years</p> <p>'Relaxations'</p> <p>1. The age is relaxable for SC/ST) candidates upto 5 years and upto 3 years for OBC candidates in respect of vacancies reserved for them.</p> <p>2. Relaxable for Government Servants upto 5 years in accordance with the instruction or orders issued by the Central Government</p> <p>3. Relaxable for teachers of government funded institutions of higher education for 5 years.</p> <p>4. Age relaxable for the PWD category candidates in</p>

<p>grading system I followed) in a concerned/relevant/allied subject from a Indian University, or an equivalent degree from an accredited university.</p>	<p>Finance, Financial Management, Financial Markets, Global Business Operation, Human Resource Development, Human Resource Management, Industrial Engineering, Industrial Management, Information System, Information Technology & Engineering, Information Technology, International Business, Knowledge Engineering, Knowledge Management, Knowledge Science, Management Science, Marketing Management, Operations Research, Organizational Development, Personal Management & Industrial Relation, Psychology, Quality Engineering & Management, Sales & Marketing Management, Software Engineering, Software Systems, Software Technology, Statistics, Strategic Management, Technology Management Family Business & Entrepreneurship Innovation, Entrepreneurship & Venture Development</p>	<p>accordance with the instruction/ orders issued by the central government /GNCT from time to time</p>
<p>(ii) Besides fulfilling the above qualifications, the candidate must have cleared the National Eligibility Test (NET) conducted by the UGC or the CSIR, or a similar test accredited by the UGC, like SLET/SET or who are or have been awarded a Ph.D Degree in accordance with the University Grants Commission (Minimum Standards and Procedure for Award of M.Phil/Ph.D. Degree) Regulations, 2009 or 2016 and their amendments from time to time as the case may be exempted from NET/SLET/SET:</p>		
<p>Provided, the candidate registered for the Ph.D. programme prior to July11, 2009, shall be governed by the provisions of the then existing Ordinance/Bye-laws/Regulations of the Institution awarding the degree and such Ph.D. candidates shall be exempted the requirement of NET/SLET/SET for requirement and appointment of Assistant Professor or equivalent positions in Universities/Colleges/Institutions subject to the fulfilment of the following conditions:-</p>		
<p>a) The Ph.D. degree of the candidates has been awarded in a regular mode; b) The Ph.D. thesis has been evaluated by at least two external examiners; c) An open Ph.D. viva voce of the candidate has been conducted; d) The Candidate has</p>		

	<p>published two research papers from his/her Ph.D. work, out of which at least one is in a refereed journal;</p> <p>e) The candidate has presented a least two papers based on his/her Ph.D. work in conference/seminars sponsored/funded/ supported by the UGC/ICSSR/CSIR or any similar agency.</p> <p>The fulfilment of these conditions is to be certified by the Registrar or the Dean (Academic Affairs) of the University concerned.</p> <p>Note: NET/SLET/SET shall also not be required for such Masters Programmes in disciplines for which NET/SLET/SET is not conducted by the UGC, CSIR or similar test accredited by the UGC, like SLET/SET.</p> <p>‘OR’</p> <p>The Ph.D. degree has been obtained from a foreign university/institution with a ranking among top 500 in the World University Ranking (at any time) by any one of the following: (i) Quacquareli Symonds (QS) (ii) the Times Higher Education (THE) or (iii) the Academic Ranking of World Universities (ARWU) of the Shanghai Jiao Tong University (Shanghai).</p>	
--	--	--

Notes :

1. Any deviation in the nomenclature of the relevant branches or degrees as mentioned above may also be considered by the University.
2. AMIE/IETE qualifications in relevant branches mentioned in the RR are also eligible.
3. B.Sc. (Engineering), B.E., B.Tech, B.S. (Four years) shall be considered as equivalent.
4. M.Sc. (Engineering), M.E., M.Tech, M.S. shall be considered as equivalent.
5. Selection Committee, may in cases of exceptional merit, recommend additional increments in case of higher qualifications, experience and academic achievements by the candidates.

6. Persons already in employment in Government Department/Autonomous Bodies/Universities under Central/State Government should apply through proper channel.
7. The University shall conduct a screening test for short listing of candidates. The shortlisted candidates will make a presentation before a committee in the concerned department and other invitees of DTU, prior to appearing before the Selection Committee.
8. If a class/division is not awarded, minimum of 60% marks in aggregate shall be considered equivalent to first class/division. If conversion formula for CGPA to percentage marks is not given/defined, CGPA will be converted into equivalent marks by multiplying the CGPA by a factor of 10.

Instrument Proposition Phase wise:

Phase – I (Pricing approx. 75L)

#	Description	Qty.	Approx. Price (in Rs.)
1	DC – 6GHz, Vector Signal Generator	01	1630000
2	Vector Modulation Option	01	496000
3	9KHz – 7.5GHz Real Time Signal Analyzer	01	1140000
4	SignalVu-PC Education Version License	01	232000
5	7.5-Digit, 1MSa/s Sample Rate Sampling Digital Multimeter	01	378000
6	Multiplexer Card	01	53900
7	Battery Simulator	01	276000
8	6 series – 25 GSa/s Sample Rate 4 Channel Oscilloscope	01	2520000
9	1GHz Bandwidth Option	01	
10	Windows 10 Option	01	98900
11	Trainer Kit with Cables & Adapter	01	600000
		Total	7424800

Phase – II(Pricing approx. 65L)

This phase is going to be expansion on Phase – I. This will add up the capabilities on Serial Bus decoding & also with custom & wideband IQ modulation Capabilities.

#	Description	Qty.	Approx. Price (in Rs.)
1	External IQ Option	01	214000
2	250MHz – Arbitrary Function Generator with 16MSa Memory	01	1320000
3	General Purpose Modulation Generation Software	01	651000
4	Bluetooth & Wireless LAN Signal Generation Software	01	632000
5	Upgrade to 6GHz Bandwidth of 6 Series Oscilloscope	01	3760000
		Total	6577000

Phase – III(Pricing approx. 1.5Cr)

This phase will add up the capabilities of 5G FR-1 extension.

#	Description	Qty.	Approx. Price (in Rs.)
1	10 Bits, 2GSamples Memory 2 Channels Arbitrary Waveform Generator	01	10900000
2	16 GSa/s Sample Rate	01	
3	5G NR library for Signal Generation & Analysis	01	2000000
4	Increase Spectrum View Capture Bandwidth to 2 GHz	01	1870000
Total			14770000

Phase – IV(Pricing approx. 40L)

This is the final Phase of the upgradation which will help to cater the complete lab setup with DUT in mmWave Band and having FR-2 of 5G NR.

#	Description	Qty.	Approx. Price (in Rs.)
1	Upgrade to 25 GSa/s Sample Rate	01	3650000
2	Up Converter in band of FR2	01	80000
3	Down Converter for Band FR2	01	80000
4	PLL Phased Lock Loop	01	50000
Total			3860000

Phase – IV can be superset and unique solution of 4x4 MIMO system which can be research subject of Massive MIMO under 3GPP standard.

Computer Configuration:

To operate Trainer kit we will need one computer which can have following configuration. With the same computer we will be able to operate Real Time Spectrum Analyzer.

Processor i7 core, 16 GB RAM, 64 Bit Operating System, Windows 10

Tentative Budget for Infrastructural Requirements

S. No.	Item description	Qty.	Per Unit Price (Rs.)	Total Price (Rs.)
1	Wooden table with Power Board and LAN connectivity (3'*6')	15	70,000/-	10,05,000/-
2	Chairs	15	10,000	1,50,000/-
3	Windows AC 1.5 Ton	4	40,000	1,60,000/-
4	Computer Intel® Core™ i5-9500 (6 Cores/9MB/6T/3.0GHz to 4.4GHz/65W) Windows 10 Pro (64bit) English Intel® Integrated Graphics 8GB 1X8GB 2666MHz DDR4 Memory M.2 256GB Class 35 Solid State Drive	15	1,10,000	16,50,000/-
5	HP Z4 Workstation, Intel Xeon W-2133, 16GB (2x8GB) RAM, 2TB Hard Disk, Graphics NVIDIA Quadro P2000 5GB (4) DP, Windows 10 Pro, DVDRW, 3 Yrs Onsite Warranty	01	3,10,000/-	3,10,000/-
6	Trainer Kit with Cables & Adapter	10	6,00,000	60,00,000/-
7	Delta Smart Display Units (Video Walls) (86inch)	02	6,10,000/-	12,20,000/-
Grand Total				1,04,95,000/-

Note: Space Requirements

A lab space of 40 feet * 40 feet is required for establishment for the center.

Budget summary

Sr. No.	Item	Amount in INR	Phase Each phase may take 6 to 8 months
1	Infrastructure: Furniture, Computers etc (Table: V)	1,04,95,000/-	Phase I
2	Instruments as per Table: I	7424800/-	Phase I
3	Instruments as per Table: II	6577000/-	Phase II
4	Instruments as per Table: III	14770000/-	Phase III
5	Instruments as per Table: IV	3860000/-	Phase IV
Total		4,31,26,800/-	

References of Lab:

- IISC Bangalore, IIT Madras, IIT Bombay, IIT Delhi, IIT Kanpur-
Research & Development in 5G Base Station and Massive MIMO
- NIT Meghalaya, NIT Nagaland- For research purpose on the IoT on
Wireless Signal Standard & study. Focusing on the Bluetooth & WLAN
study

Proposal Summary:

The overall proposal is an attempt to address the test solution needs for Wireless Communication focusing on IoT and 5G. The proposal includes all the hardware and software products which are key elements in the proposed solution.



DEPARTMENT OF ENVIRONMENTAL ENGINEERING
DELHI TECHNOLOGICAL UNIVERSITY
SHAHBAD DAULATPUR, BAWANA ROAD, DELHI-110 042
Tel. No.: 011-27890035 Website: www.dce.edu

No. DTU/HOD/Env./2020/295

Date: 09-11-2020

MINUTES OF MEETING


Meeting of Board of Studies for the Department of Environmental Engineering was held on 9th Nov. 2020 in the office of Head, Department of Environmental Engineering to discuss the revisions in B.Tech. course curriculum as per the University guidelines. Following members were present:

1. Prof. S. K. Singh, Head, Department of Environmental Engineering
2. Dr. Anil K. Haritash, Associate Professor, Department of Environmental Engineering
3. Dr. Geeta Singh, Assistant Professor, Department of Environmental Engineering
4. Mrs. Lovleen Gupta, Assistant Professor, Department of Environmental Engineering
5. Dr. Rajeev Mishra, Assistant Professor, Department of Environmental Engineering

At the outset, the Chairman welcomed all the members and started with the proceedings. Following decision was taken:

1. As discussed in the Academic Council meeting held on 4th Nov. 2020, the core course, EN-302 (Solid Waste Management) proposed for minor in Environmental Engineering is now proposed to be moved to the elective course list.

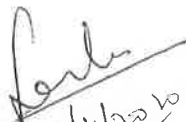
The meeting ended with vote of thanks to and from the Head.


(Prof. S.K. Singh) 9/11/2020

Chairman, Board of Studies,
Department of Environmental Engineering


for n/a


9/11/20


09/11/2020


9.11.20


09/11/2020


09-11-20

Minors offered by Department of Environmental Engineering

S. No.	Department	Minor
1.	Environmental Engineering	Environmental Engineering
2.	Environmental Engineering	Sustainability and Environmental Management
3.	Environmental Engineering	Environmental Remediation and Control

Core and Elective Courses to earn a minor in Environmental Engineering

Core Courses		Elective Courses	
Course Code	Course Title	Course Code	Course Title
EN204	Water Engineering: Design & Application	EN205	Environmental Chemistry & Microbiology
EN301	Waste Water Engineering: Design and Application	EN311	Climate Change & CDM
EN304	Air Pollution & Control	EN412	Environment & Sustainable Development
		EN404	Environmental Impact Assessment & Audit
		EN416	Non-Conventional Energy Systems
		EN306	Hydrology & Ground water Engineering
		EN316	Environmental Law & Policy
		EN302	Solid Waste Management

 — 16 —   

Core and Elective Courses to earn a minor in Sustainability and Environmental Management

Core Courses		Elective Courses	
Course Code	Course Title	Course Code	Course Title
EN412	Environment & Sustainable Development	EN420	Life Cycle Assessment
EN317	Environmental Management	EN311	Climate Change & CDM
		EN314	Green Technology
		EN416	Non-Conventional Energy Systems
		EN413	Water & Soil Conservation
		EN417	Environmental Risk assessment
		EN351	Environmental Pollution & e-waste management
		EN414	Disaster Management





09/11/2020




Core and Elective Courses to earn a minor in Environmental Remediation & Control

Core Courses		Elective Courses	
Course Code	Course Title	Course Code	Course Title
EN310	Surface and Groundwater Pollution	EN206	Engineering geology, GIS and Remote Sensing
EN413	Water & Soil Conservation	EN304	Air Pollution & Control
		EN416	Non-Conventional Energy Systems
		EN314	Green Technology
		EN417	Environmental Risk assessment
		EN305	Soil Pollution & Remediation
		EN409	Industrial waste management




29/11/2020

BACHELOR OF TECHNOLOGY (CHEMICAL ENGINEERING)

3rd Semester

S.No.	Course Name	L	T	P	Credits
PE251	Engineering Materials and Metallurgy	3	0	2	4
CH201	Chemical Engineering Process Calculations	3	1	0	4
CH203	Transport Phenomena	3	1	0	4
CH205	Chemical Engineering Thermodynamics	3	0	2	4
CH207	Engineering Design and Analysis (Process Equipment Design)	3	0	2	4
FECXXX	Foundation Elective	2	0	0	2

4th Semester

S.No.	Course Name	L	T	P	Credits
EE272	Instrumentation and Process Control	3	0	2	4
CH202	Fluid Mechanics	3	0	2	4
CH204	Chemical Reaction Engineering-I	3	0	2	4
CH206	Mechanical Operations	3	0	2	4
CH208	Heat Transfer	3	0	2	4
FECXXX	Foundation Elective	2	0	0	2

5th Semester

S.No.	Course Name	L	T	P	Credits
CH301	Polymeric Materials	3	0	2	4
CH303	Mass Transfer-I	3	0	2	4
CH3XX	Departmental Elective/General Elective-I	3/0	1/0	8/2/0	4
CH3XX	Departmental Elective/General Elective-II	3/0	1/0	8/2/0	4
CH3XX	Departmental Elective/General Elective-III	3/0	1/0	8/2/0	4
MG301	Fundamentals of Management	3	0	0	3

6th Semester

S.No.	Course Name	L	T	P	Credits
CH302	Chemical Reaction Engineering-II	3	0	2	4
CH304	Mass Transfer-II	3	0	2	4
CH306	Chemical Process Technology	3	0	2	4
CH3XX	Departmental Elective/General Elective-I	3/0	1/0	8/2/0	4
CH3XX	Departmental Elective/General Elective-II	3/0	1/0	8/2/0	4

HU302	Engineering Economics	3	0	0	3
-------	-----------------------	---	---	---	---

7th Semester

S.No.	Course Name	L	T	P	Credits
CH401	B.Tech Project-I	-	-	-	4
CH403	Training and Seminar	-	-	-	2
CH4XX	Departmental Elective-I/ General Elective-I	3/0	1/0	8/2/0	4
CH4XX	Departmental Elective/General Elective-II	3/0	1/0	8/2/0	4
CH4XX	Departmental Elective/General Elective-III	3/0	1/0	8/2/0	4
CH4XX	Departmental Elective/General Elective-IV	3/0	1/0	8/2/0	4

8th Semester

S.No.	Course Name	L	T	P	Credits
CH402	B.Tech Project-II	-	-	-	8
CH4XX	Departmental Elective/General Elective -I	3/0	1/0	8/2/0	4
CH4XX	Departmental Elective/General Elective-II	3/0	1/0	8/2/0	4
CH4XX	Departmental Elective/General Elective-III	3/0	1/0	8/2/0	4

5th semester Electives

CH305	Characterization of Materials
CH307	Petroleum Refining Engineering
CH309	Chemical Process and Simulations
CH311	Rheology
CH313	Corrosion Engineering
CH315	Plastic Technology
CH317	Resin Technology
CH319	Rubber Technology
CH321	Numerical Methods in Chemical Engineering
CH323	Biomaterials

6th semester Electives

CH308	Food Technology
CH310	Paint Technology
CH312	Polymer Processing Techniques
CH314	Fertilizer Technology
CH316	Coatings and Adhesives
CH318	Petrochemical Engineering

CH320	Packaging Technology
CH322	Tyre Technology
CH324	Heat Exchangers

7th Semester Electives

CH405	Fiber Technology
CH407	Polymer Blends and Composites
CH409	Plant Engineering and Process Economics
CH411	Advanced Mass Transfer Operations
CH413	Bio-Chemical Engineering
CH415	Rocket Propulsion and Explosives
CH417	Polymer Waste Management
CH419	Computational Fluid Dynamics
CH421	Polymer Reaction Engineering
CH423	Optimization Techniques
CH425	Application of Polymers in Biomedical
CH427	Combustion Engineering
CH429	Energy Resources
CH431	Membrane Technology

8th Semester Electives

CH404	Fuel Cell Technology
CH406	Catalysis
CH408	Specialty Polymers
CH410	Process Engineering and Design
CH412	Thermoplastic Elastomers
CH414	Non-woven Technology
CH416	Industrial Waste Management
CH418	Application of Nanotechnology in Polymers
CH420	Inorganic Polymers
CH422	Pharmaceutical Technology
CH424	Safety & Hazards in Chemical Industries
CH426	Biofuel Engineering
CH428	Energy Conservation and Recycling

I. Minor in Polymer Technology

A) For B.Tech. Chemical Engineering

Student must complete 20 Additional Credits from the following pool of subjects to get Minor in Polymer Technology

Subject Code	Name of Subject
CH311	Rheology
CH315	Plastic Technology
CH317	Resin Technology
CH319	Rubber Technology
CH310	Paint Technology
CH312	Polymer Processing Techniques
CH316	Coatings and Adhesives
CH320	Packaging Technology
CH322	Tyre Technology
CH405	Fiber Technology
CH407	Polymer Blends and Composites
CH417	Polymer Waste Management
CH425	Application of Polymers in Biomedical
CH408	Specialty Polymers
CH412	Thermoplastic Elastomers
CH414	Non-woven Technology
CH418	Application of Nanotechnology in Polymers
CH420	Inorganic Polymers

B) For Other Disciplines

Student must complete 24 Additional Credits from the following pool of subjects to get minor specialization certificate in Polymer Technology. Core is compulsory.

Core		Electives	
Subject Code	Name of Subject	Subject Code	Name of Subject
CH301	Polymer Materials	CH311	Rheology
		CH315	Plastic Technology
		CH317	Resin Technology
		CH319	Rubber Technology
		CH310	Paint Technology
		CH312	Polymer Processing Techniques
		CH316	Coatings and Adhesives
		CH320	Packaging Technology
		CH322	Tyre Technology
		CH405	Fiber Technology
		CH407	Polymer Blends and Composites

		CH417	Polymer Waste Management
		CH425	Application of Polymers in Biomedical
		CH408	Specialty Polymers
		CH412	Thermoplastic Elastomers
		CH414	Non-woven Technology
		CH418	Application of Nanotechnology in Polymers
		CH420	Inorganic Polymers

2. Minor in Petrochemical Engineering

A] For B.Tech. Chemical Engineering

Student must complete 20 Additional Credits from the following pool of subjects to get minor specialization certificate in Petrochemical Engineering

Electives	
Subject Code	Name of Subject
CH307	Petroleum Refining Engineering
CH315	Plastic Technology
CH312	Polymer Processing Techniques
CH318	Petrochemical Engineering
CH324	Heat Exchangers
CH409	Plant Engineering and Process Economics
CH411	Advanced Mass Transfer Operations
CH421	Polymer Reaction Engineering
CH427	Combustion Engineering
CH429	Energy Resources
CH406	Catalysis
CH410	Process Engineering and Design
CH426	Biofuel Engineering
CH428	Energy Conservation and Recycling

B] For Other Disciplines

Student must complete 24 Credits Additional Credits from the following pool of subjects to get minor specialization certificate in Petrochemical Engineering. Core Subjects are compulsory.

Core		Electives	
Subject Codes	Name of Subject	Subject Code	Name of Subject
CH303	Mass Transfer I	CH307	Petroleum Refining Engineering
CH304	Mass Transfer II	CH315	Plastic Technology
		CH312	Polymer Processing Techniques
		CH318	Petrochemical Engineering
		CH324	Heat Exchangers

		CH409	Plant Engineering and Process Economics
		CH411	Advanced Mass Transfer Operations
		CH421	Polymer Reaction Engineering
		CH427	Combustion Engineering
		CH429	Energy Resources
		CH406	Catalysis
		CH410	Process Engineering and Design
		CH426	Biofuel Engineering
		CH428	Energy Conservation and Recycling

3rd Semester

- | | |
|---------------------------------|---|
| 1. Subject Code: PE251 | Course Title: Engineering Materials & Metallurgy |
| 2. Contact Hours: | L: 03 T: 00 P: 02 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | ODD-III |
| 7. Subject Area: | AEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To provide students the knowledge about the properties of materials that are controlled by structure and bonding at the atomic-scale and by features at the microstructural and macroscopic levels. |

10. Details of Course:

S. No.	Contents	Contact Hours
1	Structure of metals: Crystal structure, miller indices for cubic and HCP crystals. Crystal imperfections and their effect on mechanical properties of the material. Plastic deformation of single and poly-crystalline materials.	7
2	Materials: Plain carbon steels, Effect of alloying elements; properties and uses, Tool steels, Stainless Steels, Wear resisting steels. Composition, properties, and use of non-ferrous alloys e.g. Aluminium, Copper and Zinc alloys. Corrosion: Types of corrosion, Galvanic cell, rusting of Iron, methods of protection from corrosion.	7
3	Solidification: Phases in metal system, lever rule, solidification of metal and alloys, solid solution, eutectic, eutectoid and inter-metallic compounds, Iron carbon equilibrium diagram, TTT-diagram.	7

	Heat Treatment: Heat treatment of Ferrous and Nonferrous materials, case hardening. Strengthening mechanisms	
4	Fracture: Types of Fracture of metals and alloys, brittle and ductile, fracture, fatigue failure, effect of alloying elements, design consideration. Creep: Basic consideration in the selection of material for high and low temperature service, Creep curve, effect of material variables on creep properties, brittle failure at low temperature	7
5	Composite materials: Classification of the Composite materials based on the reinforcement, characteristics, applications of composite materials in industry.	7
6	Powder Metallurgy: Principles, techniques, application and advantages, Surface treatment.	7

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Materials science and engineering : An introduction/ William D. Callister/ John Wiley & Sons	2017
2	Material Science &Engineering/ V.Raghavan/ Prentice Hall India learning Pvt.	2015
3	Material Science &Engineering/ William F. Smith, J. Hashemi, R. Prakash/ McGraw Hill	2013

1. Subject Code: **CH201**

Course Title: **Chemical Engineering Process Calculations**

2. Contact Hours:

L: 03 T: 01 P: 00

3. Examination Duration (Hrs.):

Theory: 03 Tutorial: 00 Practical: 00

4. Relative Weight:

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits:

04

6. Semester:

ODD-III

7. Subject Area:

DCC

8. Pre-requisite:

NIL

9. Objective:

:To present to the students, an introduction to the chemical engineering calculations, establish mathematical methodologies for the computation of material balances, energy balances and to present an overview of industrial chemical processes.

10. Details of Course:

S. No.	Content	Contact Hours
1	Introduction to Chemical Engineering Calculations: unit & dimensions, conversion of units, mole concept, basic concept,	7

	stoichiometric and composition relationship, limiting-excess-reactant, conversion and yield.	
2	Material Balance: Without Chemical reaction - ideal gas-law calculations, real-gas relationships, vapour pressure of immiscible liquids, solutions and problems based on Raoult's, Henry & Dalton's Law. Absolute humidity, relative humidity, saturation, dry bulb temperature, wet bulb temperature, adiabatic saturation temperature & use of psychrometric chart.	7
3	Material Balance: With chemical reaction- combustion, gas-synthesis, acid-alkali production recycle, purge, bypass in batch, stagewise and continuous operations in systems with or without chemical reaction.	7
4	Energy Balance: Review of thermo-physics, thermochemistry-law of constant heat summation. Hess's Law, standard heat of reaction, combustion and formation, problems using Hess Law.	7
5	Energy Balance: Heat balances for non-reacting processes and reaction processes. Theoretical flame temperature, Adiabatic reaction temperature, flame temperature, combustion calculation.	7
6	Applications of material and energy balances: Applied to industrial processes	7

Suggested Books:

S. No.	Name of Authors/ Books /Publishers	Year of Publication
1	Basic Principles and Calculations in Chemical Engineering/ D.M. Himmelblau,/ Prentice Hall of India.	2012
2	Stoichiometry and Process Calculations/ K.V. Narayanan and B. Lakshmikutty / Prentice Hall of India.	2006
3	Stoichiometry/ B.I. Bhatt and S.M. Vora/ Tata McGraw-Hill	2004
4	Elementary Principles of Chemical Processes/ R.M. Felder and R.W. Rousseau/ John Wiley	2016

1. Subject Code: **CH203**

2. Contact Hours:

3. Examination Duration (Hrs.):

4. Relative Weight:

5. Credits:

6. Semester:

7. Subject Area:

8. Pre-requisite:

9. Objective:

Course Title: **Transport Phenomena**

L: 03 T: 01 P: 00

Theory: 03 Practical: 00

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

04

ODD-III

DCC

Nil

To impart knowledge about transport phenomena in chemical engineering, analogy of different transport processes and how to solve problems of transport phenomena

10. Details of Course:

S. No.	Contents	Contact Hours
--------	----------	---------------

1	Introduction of transport phenomena, similarities and analogies among momentum transport, heat transport and mass transport. Basics of vector and tensors, different operations and identities of vectors and tensors used in transport phenomena	5
2	Basics of momentum transport, different axioms of momentum transport, Axiom 1 mass is conserved, Axiom 2 momentum is conserved, different models representing flow behavior of fluids, Coordinate systems, selection of control volumes. Solution of momentum balance problems using shell momentum balance for Newtonian fluids.	11
3	Equation of motion, Navier-stokes equation, Euler's equation, Solutions of momentum balance problems using Equation of motion and Navier stokes equation for Newtonian and non-Newtonian fluids (Power law and Bingham plastics fluids)	8
4	Basic concepts of heat transfer, Fourier's law of conduction, Newton's law of cooling, solution of heat transfer problems using shell heat balance, Equation of Energy, Equation of thermal energy, Viscous heat of dissipation, Solution of heat transfer problems using shell energy balance approach, Solution of heat transfer problems using Equation of Energy	10
5	Basic concepts of mass transfer, mass and molar fluxes, convective and diffusive fluxes and their correlation, Fick's law of diffusion, Equation of continuity for component balance, solution of mass transport problems using shell mass balance approach, solution of mass transport problems using equation of continuity	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Transport Phenomena 2 nd edition/ R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot/ John Wiley & Sons.	2006
2	Transport Phenomena Fundamentals/ Joel L. Plawsky/ CRC Press	2020
3	Introduction to Transport Phenomena: Momentum, Heat and Mass/ B. Raj/ PHI Learning Pvt. Ltd.	2012

1. Subject Code: **CH205** Course Title: **Chemical Engineering Thermodynamics**
2. Contact Hours: L: 03 T: 00 P: 02
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00
5. Credits: 04

6. Semester: ODD-III
 7. Subject Area: DCC
 8. Pre-requisite: NIL
 9. Objective: To familiarize the students with concepts of chemical engineering thermodynamics.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Fundamental concepts and definitions, Temperature and zeroth law of thermodynamics, Equation of states, P-V-T- relationships and application, First law of thermodynamics: Application of first law to different processes in close and open systems, Limitations of first law	8
2	Second law of thermodynamics, entropy concept, entropy and lost work calculations, Microscopic interpretation of entropy, Mathematical statement of second law, Carnot cycle for an ideal gas, Refrigeration cycle, criterion of irreversibility, Third law of thermodynamics and its applications, free energy functions and their significance in phase and chemical equilibria.	9
3	Thermodynamic property relations: Maxwell relations, Joule-Thomson coefficient, Clausius-Clapeyron equation, thermodynamic diagrams; partial molar properties, fugacity, activity and activity coefficients, variation of activity coefficient with temperature and composition, fugacity of liquid and solid, fugacity coefficient for pure species and solution, generalized correlations for fugacity coefficient, dependence of fugacity on temperatures and pressure.	9
4	Phase Equilibria: Predicting VLE of systems, VLE at low to moderate pressures, Calculation of the VLE data for a binary mixture, VLE at high pressures. Gibbs-Duhem equation and its application to vapour liquid equilibria, Thermodynamic consistency.	8
5	Chemical Reaction Equilibria: Criterion of chemical reaction equilibrium, application of equilibrium criteria to chemical reactions, the standard Gibbs energy change and the equilibrium constant, effect of temperature on the equilibrium constant, equilibrium conversions for single reactions.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Introduction to Chemical Engineering Thermodynamics/J.M. Smith, H.C. Van Ness, M.M. Abbott, J.M. Smith/ McGraw Hill	2017
2	Chemical Engineering Thermodynamics/Rao/University Press	1997
3	A Textbook of Chemical Engineering Thermodynamics/ K.V. Narayanan/ Prentice - Hall of India Pvt. Ltd.	2013

1. Subject Code: CH207 Course Title: Engineering Design and Analysis (Process Equipment Design)
 2. Contact Hours: L: 03 T: 00 P: 02
 3. Examination Duration (Hrs.): Theory: 03 Practical: 00
 4. Relative Weight: CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00
 5. Credits: 04
 6. Semester: ODD-III
 7. Subject Area: DCC
 8. Pre-requisite: NIL
 9. Objective: To impart knowledge about the mechanical design of chemical engineering equipment.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Mechanics of Materials: Stress, strain, biaxial stress; Stress-strain relationship for elastic bodies; Membrane stresses in various types of thin pressure vessels.	8
2	Pressure Vessels: Selection of type of vessels, design considerations, introduction of codes for pressure vessel design, classification of pressure vessels as per codes, design of cylindrical and spherical shells under internal and external pressure, selection and design of closures and heads; Introduction to compensation for opening; Design of jacketed portion of vessels; Design of high pressure mono-block and multilayer vessels.	10
3	Flanges: Selection of gaskets, selection of standard flanges, optimum selection of bolts for flanges, design of flanges. Inspection and testing of vessels using heads and flanges as per code specifications .	4
4	Piping: Pipe thickness calculation under internal and external pressure, introduction to flexibility analysis of piping systems .	4
5	Tall Tower Design: Design of shell, skirt, bearing plate and anchor bolts for tall tower used at high wind and seismic conditions.	6
6	Supports : Design of lug support and saddle support including bearing plates and anchor bolts	3
7	Storage Tanks: Introduction to Indian standards, filling and breathing losses; classification of storage tanks; Design of liquid and gas storage tanks with and without floating roof.	7

* Note: This is an OPEN BOOK EXAMINATION. The students are allowed to consult IS Codes, Text books, Reference books and bound lecture notes certified by the teacher concerned

Suggested Books:

S. No.	Name of Authors / Books / Publisher	Year of Publication
--------	-------------------------------------	---------------------

1	Chemical Process Equipment Design/ J.A. Shaeiwitz, R. Turton/ Prentice Hall	2017
2	Introduction of Chemical Equipment Design / B. C. Bhattacharya/ CBS Publisher.	2009
3	I.S.:2825-1969 Code for Unfired Pressure Vessels/ Bureau of Indian Standards.	1969
4	I.S.:803-1962 Code of Practice for Design, Fabrication and Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks/ Bureau of Indian Standards.	1962
5	Pressure Vessel Design Manual / D. R. Moss/ Gulf Publishers	2012
6	Pressure Vessel Design / D. Annartone/ Springer	2007

4th Semester

- | | |
|---------------------------------|---|
| 1. Subject Code: EE272 | Course Title: Process Instrumentation and Control |
| 2. Contact Hours: | L: 03 T: 00 P: 02 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-IV |
| 7. Subject Area: | AEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To familiarize the students with fundamentals of instruments and control system |

10. Details of Course:

S. No.	Contents	Contact Hours
1	Instrumentation: Classification of measuring instruments, Elements of measuring instruments, Instruments for the measurement of temperature, pressure, flow, liquid level, and moisture content, Instruments and sensors for online measurements.	8
2	Control: General Principles of process control, time domain, Laplace domain and frequency domain dynamics and control Linear Open-loop Systems: Laplace domain analysis of first and second orders systems, linearization, response to step, pulse, impulse and ramp inputs, physical examples of first and second order systems such as thermocouple, level tank, U-tube manometer, etc., interacting and non-interacting systems, distributed and lumped parameter systems, dead time.	8
3	Linear Closed-loop Systems: Controllers and final control elements, different types of control valves and their characteristics, development of block diagram, transient response of simple control systems, stability in Laplace domain.	9
4	Frequency Response: frequency domain analysis, control system design by frequency response, bode stability criterion, different methods of tuning of controllers.	9
5	Process Applications: Temperature control, level control, flow control, pressure control, concentration control in chemical industries, application to equipment such as distillation-columns, reactors, etc.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Chemical Process Control: An Introduction to Theory and Practice/ G. Stephanopoulos/ Prentice-Hall	2013
2	Process Control: Modeling, Design, and Simulation/B. Wayne Bequette/ Prentice Hall Professional	2003

3	Modern Control Engineering, 5 th Ed/ K. Ogata/ Pearson	2010
4	Instrumentation for Process Measurement & Control, 3 rd Ed./ Norman A. Anderson/ CRC Press	1997

1. Subject Code: **CH202** Course Title: **Fluid Mechanics**
2. Contact Hours: L: 03 T: 00 P: 02
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00
5. Credits: 04
6. Semester: EVEN-IV
7. Subject Area: DCC
8. Pre-requisite: NIL
9. Objective: To impart knowledge to the students about fluid mechanics and their applications

10. Details of Course:

S. No.	Contents	Contact Hours
1	Normal forces in fluids; principles governing fluid flow, Newtonian and Non-Newtonian fluids, laminar and turbulent flows; pressure drop and friction factor; velocity profiles, nature of turbulence, eddy viscosity.	9
2	Flow in boundary layers, basic equation of fluid flow, conservation of mass, momentum and energy- integral and differential approaches, Bernoulli's Equations.	9
3	Derivation of Navier-Stokes equation, dimensional analysis; dimensionless numbers and their physical significance, drag force and drag coefficient; terminal and settling velocities; hindered settling, forces on submerged bodies, buoyancy and stability.	10
4	Techniques of flow measurement: pitot tube, orifice meter, venture meter, rota-meter, notches, wet gas meter, fluid machinery: pumps, blowers and compressors.	8
5	Mixing of fluids: Types of mixers and their selection; power requirements.	6

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/reprint
1	Unit Operations in Chemical Engineering/ W.L. McCabe, J.C. Smith, and P. Harriot/ McGraw Hill.	2017
3	Fluid mechanics for chemical Engineers/ Nevers Noel de/ McGraw Hill.	2012
4	Fox & McDonald Introduction to Fluid Mechanics/P.J. Pritchard/John Wiley and sons.	2011

1. Subject Code: CH204 Course Title: Chemical Reaction Engineering -I
 2. Contact Hours: L: 03 T: 00 P: 02
 3. Examination Duration (Hrs.): Theory: 03 Practical: 00
 4. Relative Weight: CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00
 5. Credits: 04
 6. Semester: EVEN-IV
 7. Subject Area: DCC
 8. Pre-requisite: NIL
 9. Objective: To impart knowledge to the students about chemical reaction engineering

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction: Reaction rate; Kinetics of homogeneous reaction: Concentration-dependent term of a rate equation, single and multiple reaction, Elementary & Non-elementary reactions, kinetic view of equilibrium for elementary reactions, Molecularity, order of reaction, Representation of an elementary reaction, Kinetics for non-elementary reactions, Temperature dependent term of a rate equation: Arrhenius law, Collision theory, Transition-state Theory	10
2	Interpretation of batch reactor data: Constant-volume batch reactor, Integral method of data analysis: General Procedure, Irreversible unimolecular-type First-order Reaction, Irreversible Bimolecular-type Second-order Reactions, Empirical Rate Equations of n^{th} Order, Zero-order Reactions, Overall Order of Irreversible Reactions from the Half-life	10
3	Irreversible Reactions in Parallel, Autocatalytic reactions, Irreversible reactions in series, First-order Reversible Reactions, Differential method of Analysis of data: Analysis of the rate equation, Varying-Volume Batch Reactors	8
4	Material balance equation for ideal batch reactor & its use for kinetic interpretation of data and isothermal reactor design for single reactions. Analysis of CSTR & PFR and their use for kinetic interpretation and design, Comparison of batch reactor, CSTR & PFR	6
5	Concept of adiabatic & non-isothermal operations; Non Ideality: Basics of non-ideal flow, residence time distribution, States of segregation, Measurement and application of RTD, Conversion in non-ideal reactors.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Chemical Reaction Engineering/Levenspiel O./ Wiley Eastern Ltd. 3rd Ed.	2006

2	Essentials of Chemical Reaction Engineering/Fogler/ Pearson	2014
3	Introduction to Chemical Engineering Kinetics and Reactor Design/ Charles G. Hill, Thatcher W. Root/ Wiley	2014

- | | |
|---------------------------------|---|
| 1. Subject Code: CH206 | Course Title: Mechanical Operations |
| 2. Contact Hours: | L: 03 T: 00 P: 02 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-IV |
| 7. Subject Area: | DCC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To impart knowledge on particle size analysis, size reduction, separation of solid particles from fluids and flow through porous media. |

Details of Course:

S. No.	Contents	Contact Hours
1	Particle Size Analysis: Sieve analysis, size distribution, size averaging and equivalence, size estimation in sub-sieve range Size Reduction: Theory of crushing and grinding, crushing and grinding equipment and their selection. Screening: Capacity and Effectiveness of a screen, calculation of average size of particles in mixture by screen analysis, types of screens.	10
2	Agitation and Mixing: Agitation of low viscosity particle suspensions: axial flow impellers, radial flow impellers, close-clearance stirrer, unbaffled tanks, baffled tanks, basic idea for designing agitators. power consumption in agitation. Mixing of Solids: Types of mixers, power requirements, mixing index. Mixers for free flowing solids	10
3	Filtration: Flow through filter cake and medium, washing and drying of cake, filter aids, selection of filtration equipment, constant rate and constant pressure filtration, micro filtration	6
4	Settling: Motion of particles through fluids, Terminal velocity, hindered settling, Stoke's law, gravity settling processes: Classifiers, clarifiers, thickeners, flocculation, rate of sedimentation. Centrifugal Settling processes: Cyclones, hydro clones, decanters, principles of centrifugal sedimentation	8
5	Fluid-Solid Conveying: Pneumatic and hydraulic transport of solids, general characteristics and flow relations Fluidization: Fluidization and fluidized bed, conditions for fluidization, Ergun equation and Kozeny-Carman equation, minimum fluidization velocity, types of fluidization, industrial applications.	8

Suggested Books:

S. No.	Name of Authors/ Books /Publishers	Year of Publication
1	Unit Operations in Chemical Engineering/ W.L. McCabe, J.C. Smith, and P. Harriot/ McGraw Hill.	2017
2	Coulson J. H. and Richardson J.F., "Chemical Engineering, Vol. II", Butterworth-Heinemann.	2015
3	Brown G. G., "Unit Operations", CBS publishers.	1995
4	Narayanan C.M. and Bhattacharya B.C., "Mechanical Operations for Chemical Engineers", Khanna publishers.	1992

- | | |
|---------------------------------|--|
| 1. Subject Code: CH208 | Course Title: Heat Transfer |
| 2. Contact Hours: | L: 03 T: 00 P: 02 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-IV |
| 7. Subject Area: | DCC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To impart knowledge to the students about conduction, convection and heat radiation. |

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to heat transfer and involved basic equations.	4
2	Conduction: Review of Fourier's law, thermal conductivity of materials, steady and unsteady state conduction, steady state conditions, equation of planes, cylinders, hollow spheres, and problems related to these cases. Lagging of pipes and other equipment, optimum lagging thickness, heat transfer from extended surfaces (fins).	9
3	Convection: Free and forced convection, Concept of thermal boundary layer, concept of Individual and overall heat transfer coefficients, laminar and turbulent flow, Heat transfer inside & outside tubes with significance of Nusselt, Prandlt, Reynold, Biot, Fourier and Peclet number. Condensation and Boiling: Definition, film wise and drop wise condensation, Nucleate& Film boiling, Different Boiling regimes.	9
4	Radiation: Distribution of radiant energy, Definition of emissivity, absorptivity, Reflectivity and Transmissivity, concept of Black and Grey bodies, Planck's law of monochromatic radiation, Kirchhoff's law, Wein's displacement law, Stefan-Boltzmann Law, Heat exchange by radiation between two simple bodies, two parallel surfaces and between any source and receiver, Salient features of shape factor.	10

5	Heat Exchangers: Classification of heat exchangers, the construction, specification and applications, LMTD in single pass, parallel and counter flow arrangements, cross-flow arrangements, use of correction factor. Evaporation: Heat transfer to vaporization processes, single and multiple effect evaporations. Various types of evaporators	10
---	--	----

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Fundamentals of Heat & Mass Transfer/ Bergman et al/ Wiley India	2011
2	Unit Operations in Chemical Engineering/ W.L. McCabe, J.C. Smith, and P. Harriot/ McGraw Hill.	2017
3	Heat Transfer: Principles & Applications/ Dutta/ Prentice Hall	2000
4	Process Heat Transfer: Principles, Applications and Rules of Thumb, 2 nd /R.W. Serth, T.Lestina/ Academic Press	2014
5	Heat Transfer/ Holman/ McGraw Hill	2010

5th Semester

- | | |
|---------------------------------|--|
| 1. Subject Code: CH301 | Course Title: Polymer Materials |
| 2. Contact Hours: | L: 03 T: 00 P: 02 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | ODD-V |
| 7. Subject Area: | DCC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To impart knowledge of polymerization processes and properties of polymer. |
| 10. Details of Course: | |

S. No.	Contents	Contact Hours
1	General introduction to polymer structure: Classification and nomenclature of polymers, monomer and functionality, polymerization and degree of polymerization, Classification of polymerization mechanism, stepwise polymerization, radical chain (addition) polymerization, coordination polymerization, ring opening polymerization	9
2	Copolymer and their types, methods of copolymerization, techniques of polymerization: Bulk, Solution, Suspension & Emulsion, Industrial methods of polymerization, polymerization in homogenous systems, polymerization in heterogeneous systems.	8
3	Polymer molecular weight, and its distribution, method of determination of different molecular weights, Polymer Structure analysis, configuration, conformation of polymers, structure, and properties of amorphous, semi crystalline, and cross-linked polymers	8
4	Thermal properties of polymers, concept of glass transition temperature, melting and softening temperature, thermal analysis of polymers by TGA, DSC, DMTA. Polymer Crystallization and Methods of determination of crystallinity. Viscoelastic properties of Polymer, creep, stress relaxation, fatigue of polymeric materials. mechanical models	9
5	Mechanical properties of polymers strength (creep, fatigue, stress relaxation tensile, flexural and compressive), hardness, resilience, impact properties, factors affecting these properties, methods of determination of these properties. Electrical and Optical properties of polymers	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
--------	---------------------------------	-----------------------------

1	Textbook of Polymer Science/ F.W. Billmeyer/ John Wiley	2008
2	Polymer Science/ V.R. Gowarikar/ New Age International	2016
3	Properties of Polymer/ D.W. van Krevelen/ Elsevier	2003
4	Principle of Polymerization/ G Odian/ Wiley	2004
5.	Plastic Materials/ J A Brydson/ Butterworth-Heinemann.	2000
6.	Handbook of Plastics Testing and Failure Analysis/ Vishu Shah/ John Wiley & Sons	2007

1. Subject Code: **CH303** Course Title: **Mass Transfer-I**
2. Contact Hours: L: 03 T: 00 P: 02
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00
5. Credits: 04
6. Semester: ODD-V
7. Subject Area: DCC
8. Pre-requisite: NIL
9. Objective: To familiarize students about mass transfer operations.
10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction: Mass transfer operations and their classification, Diffusion: molecular diffusion, Fick' law of diffusion, equimolal counter diffusion, diffusion of A through stagnant non-diffusing B, diffusion in gases, molecular diffusion in liquids, measurement and estimation of diffusivity mass transfer between gas and liquid phases, Individual and overall mass transfer coefficients.	12
2	Interphase Mass Transfer: Theories of Mass transfer, Film theory, penetration theory and surface renewal theory. Equipment used in gas-liquid operations, co-current and countercurrent absorption processes, transfer unit: HETP, HTU and NTU concepts.	10
3	Gas Absorption: Design of plate and packed absorption columns, Scrubbers, Non-isothermal absorption, Simultaneous heat and mass transfer.	6
4	Drying of Solids: Rate of drying curves, through circulation drying, Continuous drying, Types of dryer	6
5	Humidification Operations: VLE & Enthalpy, Reference substance plots, vapour gas mixtures, concept of adiabatic saturation, psychometric charts, adiabatic operations humidification operations and water cooling operations. Dehumidification Equipments: water cooling towers & spray chambers	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Mass Transfer Operations/ Treybal/ McGraw Hill	2015
2	Unit Operations in Chemical Engineering/ W.L. McCabe, J.C. Smith, and P. Harriot/ McGraw Hill.	2017
3	Principles of Mass Transfer/ Sharma/ Prentice Hall of India	2007
4	Principles of Mass Transfer & Separation Process/ Dutta/ Prentice Hall of India	2001
5	Elements of Mass Transfer/Anatharaman & Sheriffa Begum/ Prentice Hall of India	2005

6th Semester

- | | |
|---------------------------------|--|
| 1. Subject Code: CH302 | Course Title: Chemical Reaction Engineering-II |
| 2. Contact Hours: | L: 03 T: 00 P: 02 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-VI |
| 7. Subject Area: | DCC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To enable the students to learn advance chemical reaction engineering including biochemical reactions. |
| 10. Details of Course : | |

S. No.	Contents	Contact Hours
1	Kinetics of Heterogeneous Reactions: Basic idea of catalysis, Catalyst properties, Catalytic specificity, Preparation, Testing and characterization of catalysts, Steps in catalytic reaction, Adsorption, Adsorption isotherms, Catalyst poisoning and catalyst regeneration.	8
2	Diffusion Through Porous Catalyst Particles: Fluid solid catalytic reaction kinetics, external transport process, Reaction & diffusion within porous catalysts, Effective diffusivity.	8
3	Kinetics of Fluid-Particle Reactions: Modelling of gas-solid non-catalytic reactions and determination of parameters, Combination of resistances & determination of rate controlling step.	10
4	Kinetics & Design of Fluid-Fluid Reactions: Interface behavior for liquid-phase reaction, Fluid-fluid reaction rate equations, Regimes for different reaction kinetics for liquid-liquid reactions, Concept of Enhancement factor & Hatta Number, Applications of fluid-fluid reaction rate equations to design the reactors, Fluid-solid non-catalytic reactors.	7
5	Design of Heterogeneous Reactors: Analysis of rate data design outline and selection of fixed bed, fluidized bed and slurry reactors, Reactor systems and design for gas-liquid-solid non-catalytic system. Bioreactors: Classification different bioreactors e.g. batch and continuous, mechanically and non-mechanically agitated. Design and analysis of Bioreactors, Scale up considerations of bioprocesses	7

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Elements of Chemical Reaction Engineering/ H. Scott Fogler/ Prentice Hall	2005

2	Encyclopedia of Chemical Technology/ Kirk-Othmer/ Wiley	2014
3	The Engineering of Chemical Reactions/ Schmidt/ Oxford University Press	2005
4	Elements of Reaction Engineering/ R.P.S. Srivastava/ Khanna Publishers	2008
5	Chemical Engineering Kinetics, 3rd Ed./ Smith J.M./ McGraw Hill	1981

1. Subject Code: **CH304** Course Title: **Mass Transfer-II**
2. Contact Hours: L: 03 T: 00 P: 02
3. Examination Duration (Hrs.): Theory: 03 Practical: 02
4. Relative Weight: CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00
5. Credits: 04
6. Semester: EVEN-VI
7. Subject Area: DCC
8. Pre-requisite: NIL
9. Objective: To familiarize students about different advance mass transfer operations.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Distillation: Vapor Liquid Equilibria, Raoult's Law, relative volatility, Distillation Types: Batch and Continuous, Analysis of binary distillation in trayed towers: McCabe Thiele Method, Stepwise procedure to determine the number of theoretical trays Enthalpy-concentration diagrams, simple distillation, continuous rectification of binary systems. Multistage tray tower design: McCabe and Thiele and Ponchon Savarit methods, tray efficiency, Azeotropic, extractive and steam distillation.	14
2	Liquid-liquid extraction: Extraction equipment, equilibrium diagram, choice of solvent, Single stage and multistage counter-current extraction with/without reflux, Equipment used in liquid-liquid extraction.	10
3	Solid liquid extraction: Leaching, Factors affecting the rate of leaching, Leaching Equipment	5
4.	Adsorption: Types of Adsorption, Desirable qualities of adsorbents, Adsorption equilibria- single species- Langmuir, Freundlich isotherms, Adsorption operations –single stage and multi stage.	8
5	Crystallization: Methods of forming nuclei in solution and crystal growth, Crystallizers	5

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Mass Transfer Operations/ Treybal/ McGraw Hill	2015
2	Unit Operations in Chemical Engineering/ W.L. McCabe, J.C. Smith, and P. Harriot/ McGraw Hill.	2017
3	Principles of Mass Transfer/ Sharma/ Prentice Hall of India	2007
4	Principles of Mass Transfer & Separation Process/ Dutta/ Prentice Hall of India	2001
5	Elements of Mass Transfer/Anatharaman & Sheriffa Begum/ Prentice Hall of India	2005

1. Subject Code: **CH306** Course Title: **Chemical Process Technology**
2. Contact Hours: L: 03 T: 00 P: 02
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00
5. Credits: 04
6. Semester: EVEN-VI
7. Subject Area: DCC
8. Pre-requisite: NIL
9. Objective: To familiarize students about oils, fats, agro based products etc.
10. Details of Course:

S. No.	Contents	Contact Hours
1	Representation of steady-state flow sheets for the chemical plant	5
2	Oils and fats: Major oil seeds production in India; Methods of oil extraction, Hydrogenation of oils. Soaps and detergents: cleaning action, soap and detergent manufacturing, recovery of glycerine, Fat-splitting.	9
3	Food processing and agro based Industries: Cane Sugar production and manufacturing technology, cane sugar refining, baggasse utilization, Fermentation of molasses.	9
4	Inorganic chemical industries; sulfuric acid, sodium hydroxide, ammonia and its allied products. Fertilizers: Classification of fertilizers, manufacture of ammonia based fertilizers, manufacture of phosphate fertilizers and potash fertilizers, N-P-K values.	9
5	Pulp and Paper Industries: Kraft pulp process, Sulphite pulp process, Production of paper. Recent advancements in chemical process technology.	10

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Chemical Process Technology 2 nd Ed/ Moulijn / Wiley	2013
2	Outlines of Chemical Technology/ C. E. Dryden, and M.G. Rao, (Ed.)/ Affiliated East West Press	2017
3	Sherve's Chemical Process Industries/Austin/ Mc- GrawHill	2012
4	Encyclopedia of Chemical Technology, 27 Vol Set/Kirk & Othmer (Ed.)/ Wiley	2004

7th Semester

1. Subject Code: **CH401** Course Title: **B.Tech Project-I**
2. Contact Hours: L:0 T:0 P:0
3. Examination Duration (Hrs.): Theory: 0 Practical: 0
4. Relative Weight: CWS: 0 PRS: 0 MTE: 0 ETE: 0
PRE: 0
5. Credits: 4 6. Semester: VII 7. Subject Area: DCC
8. Pre-requisite: NIL
9. Objective: To familiarize the students to work in group and develop an independent understanding of engineering and analysis of engineering systems. To guide them write and present the work done in a professional manner during the course.

1. Subject Code: **CH403** Course Title: **Training Seminar**
2. Contact Hours: L: 0 T:0 P:0
3. Examination Duration (Hrs.): Theory: 0 Practical: 0
4. Relative Weight: CWS: 0 PRS: 0 MTE: 0 ETE: 0 PRE: 0
5. Credits: 2 6. Semester: VII 7. Subject Area: DCC
8. Pre-requisite: NIL
9. Objective: To familiarize the students to the working culture of the industrial system. To make them able to write and present the work done in a professional manner during the course.

8th Semester

1. Subject Code: **CH402** Course Title: **B.Tech project-II**
2. Contact Hours: L:0 T:0 P:0
3. Examination Duration (Hrs.): Theory:0 Practical: 0
4. Relative Weight: CWS: 0 PRS: 0 MTE: 0 ETE:0 PRE: 0
5. Credits: 8 6. Semester: VIII 7. Subject Area: DCC
8. Pre-requisite: NIL

—45—

9. Objective: To familiarize the students to work in group and develop an independent understanding of engineering and analysis of engineering systems. To guide them to be able to write and present the work done in a professional manner during the course.

Departmental Elective Courses

5th Semester

Elective I and Elective II

1. Subject Code: **CH305** Course Title: **Characterization and Testing of Materials**
2. Contact Hours: L: 03 T: 00 P: 02
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00
5. Credits: 04
6. Semester: ODD-V
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To impart knowledge of Characterization techniques to the students
10. Details of Course:

S. No.	Contents	Contact Hours
1	Application of national and international standards, BIS, ISO, ASTM for testing and their significance	5
2	UV-visible, IR and Raman spectroscopy and its applications in material characterization	8
3	NMR spectroscopy in liquid and solid phase (¹ H and ¹³ C) and its applications in material characterization,	10
4	Mass spectrometry, separation techniques (GC, LC), structure elucidation of materials based on spectroscopic data	9
5	X-Ray diffraction method, scanning electron microscopy, transmission electron microscopy, and atomic force microscopy method for material characterization	10

Suggested Books:

S. No.	Name of Books/Authors/Publisher/ISBN	Year of Publication /Reprint
1	Polymer Characterization /P. Nicholas Cheremisinoff/ Elsevier/ eBook	1996
2	NMR Spectroscopy of Polymers / Kitayama, Tatsuki, Hatada, Koichi/ Springer	2004
3	Analytical Methods for Polymer Characterization / R. Yang/ CRC Press	2018

1. Subject Code: CH307	Course Title: Petroleum Refinery Engineering
2. Contact Hours:	L: 03 T: 01 P: 00
3. Examination Duration (Hrs.):	Theory: 03 Practical: 00
4. Relative Weight:	CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits:	04
6. Semester:	ODD-V
7. Subject Area:	DEC/GEC
8. Pre-requisite:	NIL
9. Objective:	To familiarize students with knowledge of petroleum, its refining and properties.

10. Details of Course

S. No.	Contents	Contact Hours
1	Concepts of oil refining, Composition of crude oil, refinery feedstocks and products, Physical and Chemical properties, Laboratory tests.	6
2	Evaluation of oil stocks, Dehydration and desalting of crude, Crude Assay ASTM TBP distillations evaluation of crude oil properties, API gravity various average boiling points and mid percent curves, Evaluation of properties of crude oil and its fractions, Design concept of crude oil distillation column design.	9
3	Thermal and Catalytic cracking, Coking and Thermal process, Delayed coking, Catalytic cracking, Cracking reactions, Zeolite catalysts, Cracking Feedstocks and reactors, Effect of process variables, FCC Cracking, Catalyst coking and regeneration, Design concepts, New Designs for Fluidized-Bed Catalytic Cracking Units, Hydrocracking, Catalytic Reforming, Reformer feed reforming reactor design continuous and semi regenerative process.	10
4	Isomerization process, Reactions, Effects of process variables, Alkylation process, Feedstocks, reactions, products, catalysts and effect of process variables, Polymerization, Process and reactions, catalysts and effect of process variables.	8
5	Environmental issues and New trends in petroleum refinery operations, Ecological consideration in petroleum refinery, Waste water treatment, control of air pollution, Alternative energy sources, Biodiesel, Hydrogen energy from biomass.	9

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Fundamentals of Petroleum Refining/ Fahim, Alsabhaf and Elkilani / Elsevier	2010
2	Petroleum Refining Design and Applications Handbook/ A.K. Coker/ John Wiley & Sons.	2018
3	Petroleum Refining Processes/ James G. Speight, Baki Ozum/ CRC Press	2001

4	Petroleum Refining Technology/ Indra Deo Mall/ CBS	2015
---	---	------

1. Subject Code: **CH309** Course Title: **Chemical Process Simulations**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-V
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To study the modeling & simulation techniques of chemical processes and to gain skills in using process simulators

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction: Use and scope of mathematical modeling, Principles of model formulation, Role and importance of steady-state and dynamic simulation, Classification of models, Model building, Modeling difficulties, Degree-of-freedom analysis, Selection of design variables, Review of numerical techniques, Model simulation	8
2	Fundamental Laws: Equations of continuity, energy, momentum, and state, Transport properties, Equilibrium and chemical kinetics, Review of thermodynamic correlations for the estimation of physical properties like phase equilibria, bubble and dew points.	8
3	Modeling of Specific Systems-I: Constant and variable holdup CSTRs under isothermal and non-isothermal conditions, Stability analysis, Gas phase pressurized CSTR, Two phase CSTR, Non-isothermal PFR, Batch and semi-batch reactors,	8
4	Modeling of Specific Systems-II: Heat conduction in a bar, Laminar flow of Newtonian liquid in a pipe, Gravity flow tank, Single component vaporizer, Multi-component flash drum, Absorption column, Ideal binary distillation column and non-ideal multi-component distillation column, Batch distillation with holdup etc.	10
5	Simulation: Simulation of the models, Sequential modular approach, Equation oriented approach, Partitioning and tearing, Introduction and use of process simulation software (Aspen Plus/ Aspen Hysys) for flow sheet simulation.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
--------	---------------------------------	------------------------------

1	Process Control: Modeling, Design, and Simulation/ B.W. Bequette/ Prentice Hall Professional.	2003
2	Process Modeling and Simulation for Chemical Engineers: Theory and Practice/ S.R. Upreti/ John Wiley & Sons	2017

1. Subject Code: **CH311** Course Title: **Rheology**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-V
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To enable the students to learn about polymer rheology
and their importance.

10. Details of Course

S. No.	Contents	Contact Hours
1	Linear viscoelastic model, stress relaxation and creep, non-linear viscoelasticity - normal stress difference in shear, shear thinning, interrelations between shear functions, extensional thickening, differential-type constitutive equations - single mode differential constitutive equations and multimode constitutive equations for viscoelastic fluids, integral type constitutive equations, rate-type constitutive equations for viscoelastic fluids, material functions for steady state shear flow, oscillatory shear flow, material functions for steady state extensional flow.	10
2	Shear rheometer: sliding plates, falling ball rheometer, concentric cylinder rheometer, cone and plate rheometer, parallel disks, capillary rheometer, slit rheometer and squeezing flow behavior.	8
3	Extensional rheometry: simple extension - end clamps, rotating clamps, buoyancy bath, spinning drop, lubricated compression, planar squeezing, sheet stretching, multiaxial extension, fiber spinning, tubeless siphon, bubble collapse, stagnation flow.	8
4	Rheology of polymeric liquids: polymer chain conformation, zero shear viscosity, rheology of dilute polymer solutions, entanglement, Repetition Model, effect of long chain branching, effect of molecular weight distribution, temperature dependence.	8
5	Rheology in polymer processing operations: Calendaring and two roll mill, Twin screw extruders, Blow molding, Wire coating, Thermoforming, Sheet extrusion, Internal mixers, Rubber extrusion	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Rheology, Principles, Measurements and Applications/ Christopher W. Macasko/ Wiley VCH	1994
2	Rheology: Concepts, Methods, and Applications/ A.Y. Malkin, A.I. Isayev/ Elsevier	2017
3	Rheology - Volume II/ C. Gallegos / EOLSS Publications.	2010
4	Non-Newtonian Flow and Applied Rheology: Engineering Applications/ R. P. Chhabra, J.F. Richardson/ Butterworth-Heinemann.	2011

1. Subject Code: **CH313** Course Title: **Corrosion Engineering**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-V
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To enable the students to learn about the electrochemistry, chemical and biological aspects of corrosion.

10. Details of Course

S. No.	Contents	Contact Hours
1	Corrosion, Classification of corrosion, Electrochemistry of corrosion, Galvanic and electrolytic cells, Potential measurements, EMF and Galvanic series, Galvanic corrosion and bimetallic contacts, Eh-pH diagrams, Copper, Aluminium and general corrosion diagrams.	10
2	Electrode kinetics and polarization phenomena, Exchange current density, Polarization techniques to measure corrosion rates, Mixed potential theory, Activation and diffusion controlled mixed electrodes.	9
3	Methods of corrosion prevention and control, Design, coatings and inhibition, Cathodic protection, Stray current corrosion, Passivity phenomena and development of corrosion resistant alloys, Anodic control.	9
4	Biological aspects of corrosion, Microbially Induced Corrosion (MIC), Principles, Types, environments and microbiology, Biofilms, Corrosion by aerobic and anaerobic bacteria, Depolarization theory, Case studies, Failure analyses, Prevention of MIC, Corrosion of medical implants, Biocorrosion of concrete.	9
5	Metallurgical properties influencing corrosion.	5

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Principles of Corrosion Engineering and Corrosion Control/ Z. Ahmad, A. Alfantazi/ Butterworth-Heinemann	2019
2	Corrosion Engineering: Principles and Solved Problems/ B.N. Popov/ Elsevier.	2015
3	Corrosion Engineering and Cathodic Protection Handbook/ V. Cicek/ John Wiley & Sons.	2017

1. Subject Code: **CH315**

Course Title: **Plastic Technology**

2. Contact Hours:

L: 03 T: 01 P: 00

3. Examination Duration (Hrs.):

Theory: 03 Practical: 00

4. Relative Weight:

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits:

04

6. Semester:

ODD-V

7. Subject Area:

DEC/GEC

8. Pre-requisite:

NIL

9. Objective:

To impart knowledge about industrial preparation, properties and application of polymers.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Commodity plastics: Manufacture, properties and applications of polyethylene, polypropylene, polyvinyl chloride polyacrylate, polymethyl methacrylate, polyvinyl acetate, polyvinyl alcohol.	14
2	Engineering plastics: Industrial preparation, properties and applications of polyethylene terephthalate, polybutylene terphthalate, polyamides, polycarbonate, polyacetal, polystyrene.	14
3	Thermosetting polymers: Preparation, properties and applications of phenol formaldehyde, unsaturated polyester, urea and melamine formaldehyde, epoxy resins.	10
4	Recent advancements in polymeric materials.	4

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
	Brydson's Plastics Materials/ M. Gilbert/ Elsevier	2016

1	Plastics Technology: Introduction and Fundamentals/ C. Bonten/ Carl Hanser Verlag GmbH & Company KG	2019
2	Plastics Technology Handbook, Fourth Edition/ M. Chanda, S.K. Roy/ CRC Press.	2006

1. Subject Code: **CH317** Course Title: **Resin Technology**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-V
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To aware students about resin, their classification and applications.

10. Details of Course

S. No.	Contents	Contact Hours
1	Resins and resinous state, Classification, Natural and synthetic resins, Composition, Purification and Uses, Modification of natural resins.	7
2	Polyester Resins: Curing of resins, Catalysts and Accelerators, Water reducible polyesters, High solid polyesters/ polyesters for powder coatings, Moulding compositions, DMC, SMC, fibre and film forming compositions.	8
3	Phenolic Resins: Basic components, Theory of resinification, Reaction mechanism, Effect of ratio of reacting components and pH on reaction mechanism, Novolacs and Resol, Curing and moulding, Applications of phenolic resins.	9
4	Amino Resins: Synthesis and properties of UF and MF resins, Theory of resinification, Reaction mechanism, Effect of pH on the reaction mechanism, s, Curing and moulding, Applications of amino resins.	9
5	Alkyd Resins: Functionality concepts, Use of polyfunctional acids and alcohols, phthalic acid resins, Manufacturing, Types of modifications and properties of modified alkyd resins, Applications of alkyd resins.	9

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	The Complete Book on Adhesives, Glues & Resins Technology/ NPCS Board of Consultants & Engineers	2017
2	Epoxy Resins Technology Handbook/ H. Panda/ Asia Pacific Business Press Inc.	2019

3	Synthetic Resins Technology Handbook/ NIR Board of Consultants & Engineers	2005
4	The Complete Book on Adhesives, Glues & Resins Technology/ NPCS Board of Consultants & Engineers	2007

1. Subject Code: **CH319** Course Title: **Rubber Technology**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-V
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To impart knowledge about rubber technology and their applications.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to rubber, elasticity of rubber chain, elasticity of a network, thermodynamics of rubber elasticity, morphology of rubber, structure property relationship in rubbers, non elastomeric properties, chemical reactivity solution properties.	8
2	Natural Rubber: Source, Chemical Formula, Molecular weight distribution, concept of Sol, Gel, Microgel and Macrogel. Natural rubber from latex, field latex composition, methods of concentration and stabilization of latex, effect of electrolyte and protein, processing of latex into sheet and pale crepe rubber.	8
3	Synthetic Rubbers: preparation, properties and application of styrene butadiene, polybutadiene, polyisoprene, ethylene propylene, thiokol, butyl, nitrile, silicon and polyurethane rubber.	8
4	Rubber additives and compounding: Pre-vulcanized latex, Vulcanizing agents, vulcanization theory, activators, accelerator, fillers, softeners, antioxidants, peptizers, retarders, stiffeners, flame retardants, colors and pigments, tackifying agents, blowing agents, bonding agents, compound development and compounding of rubbers, Principle and working of Mooney viscometer.	9
5	Manufacture of latex products by impregnation and spreading process, casting impregnation, dipping process, latex coatings, latex cement and adhesives, latex thread and coir, latex foam. Manufacture of rubber products. Manufacture of rubber products as Tubes, Hoses, Footwear.	9

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	The Science & Technology of Rubber/ Erman & Ronald/ Academic Press	2013

2	Hand Book of Rubber Formulations: Rubber Technology/ S.P. Athavale/ Notion Press.	2018
3	Rubber Technology Vol. 1 & Vol. 2/ S.C. Bhatia, A. Goel/ Woodhead Publishing India Pvt Limited	2019
4	Rubber Compounding: Chemistry and Applications/ Rodgers/ CRC Press	2015

1. Subject Code: **CH321**

Course Title: **Numerical Methods in Chemical Engineering**

2. Contact Hours:

L: 03 T: 01 P: 00

3. Examination Duration (Hrs.):

Theory: 05 Practical: 00

4. Relative Weight:

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits:

04

6. Semester:

ODD-V

7. Subject Area:

DEC/GEC

8. Pre-requisite:

NIL

9. Objective:

To enable the students to learn errors, equations, curve-fittings and numerical solutions.

10. Details of Course

S. No.	Contents	Contact Hours
1	Error Analysis: Taylor series expansion, Truncation error. Round-off error vs. Chopping-off error. Propagation of Error.	8
2	Solution of simultaneous linear equations: Cramer's rule, Gauss elimination Method, Gauss-Jordon Method, and LU Decomposition, Gauss-Seidel and Relaxation Methods, Iterative method - Jacobi iteration, Application in steady-state solution of isothermal CSTR.	8
3	Solution of Non-linear Algebraic equations: Bisection method, Newton-Raphson method, Secant method, Modified Newton-Raphson method for multiple roots - Application in thermodynamic property calculation, bubble point and dew point calculation. Finding of multiple roots of a polynomial, Solution of a set of non-linear equations - Newton's method, Multivariable Newton-Raphson Technique. Jacobian matrix, characteristics equations and stability.	10
4	Curve-fitting: Least-square method for straight line and polynomial (Linear Regression), Newton's interpolation formulae (equal intervals), Divided Difference (Unequal intervals), differentiation formulae, Integration formulae (Trapezoidal, Simpson's 1/3 and 3/8 rules), Extrapolation Technique of Richardson and Gaunt.	8
5	Numerical Solution of ODE: Initial value problems using Finite difference Techniques; Runge-Kutta methods, Step-size control; Solution of a set of ODEs; Application in chemical and bio-chemical reactions; Stability analysis.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
--------	---------------------------------	------------------------------

-54-

1	Introduction to Numerical Methods in Chemical Engineering, Second Edition/ P. AHUJA/ PHI Learning Pvt. Ltd.	2019
2	MATLAB Numerical Methods with Chemical Engineering Applications/ Kamal I. M. Al-Malah/ McGraw Hill	2013
3	Numerical Methods and Modeling for Chemical Engineers/ M.E. Davis/ Courier Corporation	2013
4	Numerical Methods with Chemical Engineering Applications/ K.D. Dorfman, P. Daoutidis/ Cambridge University Press.	2017

1. Subject Code: **CH323** Course Title: **Biomaterials**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-V
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To enable the students to learn biomaterials, polymeric implant materials and bioceramics.

10. Details of Course

S. No.	Contents	Contact Hours
1	Biocompatibility, Biomaterials and their requirements, Classification, Effects of physiological fluid on the properties of biomaterials. Biological responses. Surface, physical and mechanical properties, Standards of implant materials.	8
2	Metallic implant materials: Alloys, Importance of corrosion cracking, Host tissue reaction, Importance of passive films for tissue adhesion, Hard tissue replacement implant, Soft tissue replacement implants.	9
3	Polymeric implant materials: Thermoplastics, Thermosetting, biopolymers and biodegradable polymers for implant, Properties of polymeric materials for implant, Controlled release systems, Synthetic polymeric membranes and their biological applications.	9
4	Concepts of bioceramics, Importance of wear resistance and low fracture toughness, Host tissue reactions, Importance of interfacial tissue reaction, Mechanics of improvement of properties by incorporating different elements, Composite theory of fiber reinforcement, Polymers filled with osteogenic fillers, Host tissue reactions.	8
5	Blood and tissue compatibility, Toxicity tests, Acute and chronic toxicity studies, Sensitization, Carcinogenicity, Mutagenicity and related tests. In vitro mechanical testing, Corrosion studies, In vivo testing, Biological performance of implants.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Biomaterials: Physics and Chemistry/ R. Pignatello, T. Musumeci/ BoD – Books	2018
2	Biomaterials: Principles and Practices/ J.Y. Wong, J.D. Bronzino, D.R. Peterson/ CRC Press.	2012
3	Foundations of Biomaterials Engineering/ M.C. Tanzi, S. Farè, G. Candiani/ Academic Press.	2019

Departmental Elective Courses

6th Semester

Elective III and Elective IV

- | | |
|---------------------------------|---|
| 1. Subject Code: CH308 | Course Title: Food Technology |
| 2. Contact Hours: | L: 03 T: 01 P: 00 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-VI |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To make student aware about the food chemistry and applications of polymer in food packaging. |

10. Details of Course

S. No.	Contents	Contact Hours
1	Food chemistry: Composition of foods, Water relationships in food, chemistry of carbohydrates, proteins, amino acids, lipids, vitamins and their functions, Bioavailability and stability of nutrients, Nutritive value of foods, Antioxidants, Flavoring agents, Food Analysis, Food additives.	8
2	Food Microbiology: Microorganisms in foods, Factors that influence the development of microbes in food, Biotechnological improvements, Microbial growth pattern, Spoilage and chemical changes of food, Food borne intoxicants, infections and mycotoxins, Newer methods of food processing.	9
3	Fermentation products: Production of dairy products, Manufacture of milk products, Fermented foods and vegetables, Distilled beverages: Alcohol, wine, brandy and beer.	8
4	Food preservation and storage: Principles of food preservation; Physical, chemical and biological methods, Food preservation with low and high temperatures, drying, Indicator and Food-borne Pathogens.	9
5	Food packaging: Packaging and canning of foods, Active and intelligent packaging, Antimicrobial food packaging, Non-migratory bioactive polymers in food packaging, Plastics for food packaging.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Objective Food Science & Technology, 3rd Ed./ D. Mudgil, S.B. Mudgil/ Scientific Publishers	2019
2	Introduction to Food Science and Technology/ G.F. Stewart, M.A. Amerine/ Elsevier	2012

4	Food processing and preservation/ Sivashankar/ Prentice – Hall of India Pvt.	2002
5	Food-borne Pathogens/ A.M. Emerging/ Woodhead Publ.	2006

1. Subject Code: **CH310** Course Title: **Paint Technology**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: EVEN-VI
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To familiarize the students with paint, its coating properties and environmental impact.

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction to Surface coatings, Classification, Paints, Varnishes, Lacquer, Pigment, Extender, Composition of surface coatings, Global scenario and future prospective of Indian Paint Industry, Aesthetics and safety standards.	8
2	Inorganic pigments and extenders, Synthesis, micronisation and surface treatment of pigments, Source, manufacture, properties and uses of extenders, pigments such as carbonates, Silicates, Sulphates and Oxides; Extender mixtures, Calcined Pigments and Extenders, Nano pigments and extenders.	8
3	Organic pigments and dyestuffs: Dyes and pigments, Chemical structures and their colour imparting behaviours, Auxochromes and chromophores, Influence of physical factors; colour psychology. Natural organic pigments, Coaltar distillation products, Mordants and precipitants, Bases for colour striking and lakes, miscellaneous salts and chemicals. Chemical reactions for synthesis of various dyes and pigments, Synthetic organic pigments: Azo pigments, Basic and acid dyes pigments, Miscellaneous organic pigments.	12
4	Special effect pigments like pearlescent, nacreous, phosphorescent, fluorescent and luminescent, IR reflecting pigments, thermochromic pigments, polymeric pigments, invisible pigments, High performance Pigments & dyes, Comparison of organic and inorganic pigments, Colour index name and number, Colour coding systems.	7
5	Environmental resistance and ageing properties of paints and coatings, natural & accelerated outdoor weathering tests, weather-o-meter, Evaluation of water based paints, Exterior test protocol, In-can and dry film preservation, Hygiene surfaces.	7

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Paint Technology handbook/ R. Talbert/ CRC Press	2008
2	Introduction to Paint Chemistry and Principles of Paint Technology/ G. P. A. Turner/ Springer	2014
3	Paints Pigments Varnishes and Enamels Technology Handbook with Process and Formulations/ NIIR Board	2016

1. Subject Code: **CH312** Course Title: **Polymer Processing Techniques**
2. Contact Hours: L: 03 T: 00 P: 02
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00
5. Credits: 04
6. Semester: EVEN-VI
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To impart knowledge of polymer processing to the students

10. Details of Course:

S. No.	Contents	Contact Hours
1	Plastics additives and compounding: Antioxidants, metal deactivators, stabilizers, plasticizers, lubricants, processing aids, impact modifiers, fillers and reinforcements, colorants, flame retardants, anti-static agents, blowing agents, nucleating agents, compound development and compounding of plastics.	7
2	Principle of mixing and mixers: Introduction, mechanism of mixing, practical mixing variables. Types of mixers: roll mills, internal batch mixers, sigma mixers, high speed mixer, blending, kneading and granulating equipment.	5
3	Extrusion: Principle of extrusion, Screw design, Qualitative and quantitative aspects of mechanism of screw extrusion and effects of screw and die design, Extrusion Dies: Constructional features of dies, equipment for extrusion, tubes, rods, pipes, blown film, cast film, Oriented film, Sheet extrusion, coating and lamination; processing parameters; Trouble shooting of processing techniques; twin screw extruder, types of twin screw extruder; process parameters in twin screw extruder. Construction features of vent Extruder	9
4	Compression molding machine: types, principles of operations, molding cycle, meaning of terms bulk factor and flow properties as applied to molding materials, the interplay of heat, pressure, friction, catalysts etc. for thermosetting materials; trouble shooting	6
5	Injection molding machine-machine description study, types and limitations, working principles, process variables, trouble shootings, gas	9

	assisted injection molding, structural foam molding, reaction injection molding process, their industrial applications; trouble shooting	
6	Blow molding process, principles and description of blow mold, extrusion & injection stretch blow molding, parison control, trouble shooting. Miscellaneous processing methods: casting, rotational molding, decoration of polymers, working principles of calendaring and thermoforming process	6

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Handbook of Plastic Processes/ Harper/ Wiley Interscience	2006
2	Principles of Polymer Processing/ Tadmor & Gogos/ Wiley Interscience	2013
3	Plastics Engineering/ R J Crawford/ Butterworths	2013
4	Polymer Extrusion/ Chris Rauwendaal/ Carl Hanser Verlag GmbH & Company KG,	2019
5	Plastic Materials/ J A Brydson/ Butterworth-Heinemann	2007

- | | |
|---------------------------------|--|
| 1. Subject Code: CH314 | Course Title: Fertilizer Technology |
| 2. Contact Hours: | L: 03 T: 01 P: 00 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-VI |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To impart knowledge about the properties, applications and packaging of fertilizers. |

10. Details of Course

S. No.	Contents	Contact Hours
1	Chemical fertilizers and organic manures; types of chemical fertilizers; Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.	9
2	Phosphatic fertilisers, phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.	9

3	Complex and NPK fertilisers: Methods of production of ammonium phosphates, nitrophosphates, urea and various grades of NPK fertilizers.	8
4	Miscellaneous fertilisers: Mixed fertilizers and granulated mixtures; biofertilizers, Nutrients, Secondary and micro nutrients; Fluid fertilizers, Controlled release fertilizers.	9
5	Applications of polymers in fertilizer industry	7

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Fertilizer Technology and Management/ B. Mishra/ I.K. International Publishing House Pvt. Limited	2012
2	Manual of Fertilizer Processing/ Nielsson/ Routledge.	2018
3	The Chemistry and Technology of Fertilizers/ Sauchelli/ ACS monograph No.148, Reinhold Publishing Corp. New York.	2004
4	Organic Fertilizers: From Basic Concepts to Applied Outcomes/ M. Larramendy, S. Soloneski/ BoD – Books on Demand.	2016

- | | |
|---------------------------------|---|
| 1. Subject Code: CH316 | Course Title: Coatings and Adhesives |
| 2. Contact Hours: | L: 03 T: 01 P: 00 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-VI |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To impart knowledge about polymeric coatings, adhesives and their applications. |

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction & classification of adhesives, mechanism of adhesion of polymeric coatings on various substrates, chemically reactive adhesives	10
2	Preparation of adhesives, animal glue, protein adhesives, starch adhesives, synthetic resin adhesives, rubber based adhesives, cellulose & silicate adhesives, industrial application of adhesives.	10
3	Solvent based polymeric coatings, Water based polymeric coatings, UV and EB curable coatings, 100% convertible coatings, Selection criteria of coating for various substrates.	10

4	Coating techniques for various substrates	8
5	Health hazards and environmental aspects of coatings during manufacturing and applications.	4

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Coatings Technology Handbook, 3 rd Ed/ Tracton/ CRC Press	2005
2	Organic Coatings: Science and Technology, 3 rd Ed/ Wicks et al/ Wiley	2007
3	Green Chemistry for Surface Coatings, Inks and Adhesives/ R. Hoefer, A. Matharu, Z. Zhang/ Royal Society of Chemistry	2019
4	Hand Book of Pressure Sensitive Adhesives and Coatings/ S.P. Athavale/ Notion Press.	2018

- | | |
|---------------------------------|---|
| 1. Subject Code: CH318 | Course Title: Petrochemical Engineering |
| 2. Contact Hours: | L: 03 T: 01 P: 00 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-VI |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To make student aware about the theory, principle and applications of membrane. |

10. Details of Course

S. No.	Contents	Contact Hours
1	Petrochemicals Industry Overview, Formaldehyde and Chloromethane, Hydrocarbon Steam Cracking for Petrochemicals, Vinyl Chloride from Ethylene, Ethylene oxide and Ethanolamines	10
2	Isopropanol and Acetone from Propylene, Cumene and Acrylonitrile from Propylene, Isoprene and Oxoprocessing, Butadiene and Benzene Manufacture, Phenol from Cumene and Toluene, Phenol from Benzene	8
3	Styrene and Pthalic Anhydride Production, Manufacture of Maleic Anhydride and DDT, Manufacture of Phenol Form aldehyde, Viscose Rayon and Nylon	8
4	Natural gas processing and value addition, olefin production technologies, Novel operations used in petrochemical Industries.	8

5	Chemical recovery from black liquor, Manufacture of Ethanol from Molasses, Biofuel, bioethanol, biodiesel, Biofuels from lignocellulose biomass	8
---	---	---

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Fundamentals of Petroleum and Petrochemical Engineering/ U.R. Chaudhuri/ CRC Press	2011
	Introduction to Petroleum Engineering/ John R. Fanchi, Richard L. Christiansen/ John Wiley & Sons.	2016
2	Handbook of Petroleum Refining Processes; 3 rd Ed/ Meyers/ McGraw-Hill	2004
4	Petroleum Refining Technology/ Indra Deo Mall/ CBS	2015

- | | |
|---------------------------------|--|
| 1. Subject Code: CH320 | Course Title: Packaging Technology |
| 2. Contact Hours: | L: 03 T: 01 P: 00 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-VI |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To familiarize students with packaging materials, their testing and quality control. |

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction: Packaging in production and marketing; Packaging characteristics, Physical properties; Mechanism of spoilage, degradation, corrosion & their prevention; Compatibility: permissible plasticizers and their migration to food products; Package design.	8
2	Packaging Materials: Papers and speciality papers, Cellulosic films and laminates; Plastics in packaging: PE, PP, PS, PVC, PVDC, Nylon, Polyester and their combinations; Expanded PE, PS and bubble films; Glass containers, ampoules and vials; Composite containers, drums and paper tubes; Aluminium foils, laminates and coating; Single layer and multilayer polymer packaging.	8
3	Ancillary materials: Adhesives, Adhesive tapes; Cushioning materials and properties, Reinforcements; Stitching methods; Seals and	9

	enclosures; Lining compounds and lacquers; Labels and instant labeling; bar coding	
4	Graphic design; Printing techniques, Printing inks and print evaluations.	8
5	Testing, Standards and Quality control: Mechanical testing, resistance to light, insect and mould. Barrier testing for air, oxygen etc., shelf life, Seal tests. Standards- basic concepts, standards for rigid and non rigid and ancillary materials, standards for export packages, ISO 9000 and implications. Eco packaging and regulations.	9

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Materials for Advanced Packaging/ Lu/ Springer	2009
2	Packaging Technology: Fundamentals, Materials and Processes/ A. Emblem/ Elsevier	2012
3	Plastic Packaging Materials for Food: Barrier Function, Mass Transport, Quality Assurance, and Legislation/ Piringer & Baner/ Wiley	2008
4	Fundamentals of Packaging Technology/ S. Natarajan, M. Govindarajan, B. Kumar/ PHI Learning Pvt. Ltd.	2014

1. Subject Code: **CH422**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-VII
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To familiarize the students with tyre, its design and manufacturing.

10. Details of Course

S. No.	Contents	Contact Hours
1	Importance of tyres, Functions and desirable properties of tyres, Classification of tyres, Sizing & Designation, Tyre components, Problems associated with tyres and their remedies.	9
2	Aspects of tyre design, Analysis of motive forces, Types of bonding, Set of service conditions, Tyre size requirements, Safety requirements, Tread design, Role of foot print area and factors affecting tread life, Various types of tread pattern, Carcass design, Role of various fibres used in carcass, Estimation of number of plies, Bead design, Various configurations of wires in bead assembly.	10
3	Compound design, Role of various mixing ingredients, various recipes, Compound mixing, Mixing equipments.	7

4	Extrusion of components, Tyre and wire cord manufacture, Component preparation, Green tyre building, Pre- and post-curing operations/treatments.	8
5	Tyre Testing and evaluation, Carcass strength, Resistance to bead unseating, Machine simulation tests, Indoor laboratory testing, Field test on road, Proving grounds, Latest testing techniques.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Tyre Technology 3 rd Ed/ T. French/ Adam Hilger	2010
2	Technology Of Rubber And Rubber Goods Industries/ Eiri/ Engineers India Research In.	2007
3	Hand Book of Rubber Formulations: Rubber Technology/ S.P. Athavale/ Notion Press.	2018
4	Rubber Technology Vol. 1 & Vol. 2/ S.C. Bhatia, A. Goel/ Woodhead Publishing India Pvt Limited	2019
5.	Technology of Rubber And Rubber Goods Industries/ Eiri Consultants and Engineers/Engineers India Research In./ Sudhir Gupta	2005

- | | |
|---------------------------------|--|
| 1. Subject Code: CH324 | Course Title: Heat Exchangers |
| 2. Contact Hours: | L: 03 T: 01 P: 00 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-VI |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To provide the knowledge of heat exchanger application design and simulations. |

10. Details of Course

S. No.	Contents	Contact Hours
1	Types of heat exchangers and their applications. Flow arrangements and temperature distributions in transfer type of heat exchangers. Overall heat transfer coefficient;- Clean overall heat transfer coefficient, dirt factor dirt overall heat transfer coefficient, dirt factors for various process services. Basic design equation. Mean temperature difference Concept: - LMTD for parallel flow and counter flow arrangement, correction factor for LMTD for cross flow and multi -pass heat exchangers.	8

2	Shell and Tube Heat Exchangers: Constructional features. Applications. Effectiveness-NTU method for heat exchanger design/ analysis. Rating and sizing problem. Correlations for tube side pressure drop and heat transfer coefficients. Pressure drop and heat transfer coefficient correlations for shell side flow.	8
3	Effect of By – Pass and Leakage Calculation Procedure for Shell and Tube Heat Exchanger: Heat balance equations: LMTD: reference temperature calculations: evaluation of fluid properties: flow assignments: tube side flow area calculations; viscosity correction factor, shell side equivalent diameter, calculation of shell side heat transfer coefficient, evaluation for wall temperature, evaluation of overall heat transfer coefficient, Calculation of surface area. Calculations of tube side and shell side pressure drops.	10
4	Double Pipe Heat Exchangers: Constructional features. Applications. Design parameters :- tube side and shell side film coefficients cut and twist factor, fin efficiency, overall heat transfer coefficient, mean temperature difference, available surface area, fin geometry fin height, number of fins, tube side and shell side pressure drop. Calculation procedure for the design/analysis of double pipe heat exchanger.	8
5	Compact Heat Exchangers: Introduction; definition of Geometric Terms: plate fin surface geometries and surface performance data; correlation of heat transfer and friction data; Goodness factor comparisons; specification of rating and sizing problems; calculation procedure for a rating problem.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Heat Exchangers: Design, Experiment and Simulation/ S.M.S. Murshed, M.M. Lopes/ BoD – Books on Demand	2017
2	Heat Exchanger Design Handbook, Second Edition/ K. Thulukkanam/ CRC Press.	2013
3	Fundamentals of Heat Exchanger Design/ R.K. Shah, D.P. Sekulic/ John Wiley & Sons	2003

Departmental Elective Courses

7th Semester

Elective V and Elective VI

- | | |
|---------------------------------|--|
| 1. Subject Code: CH405 | Course Title: Fibre Technology |
| 2. Contact Hours: | L: 03 T: 00 P: 02 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | ODD-VII |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To impart knowledge about fibre, their spinning and preparation to the students. |

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to fibres and basic terminology, Characteristics of fibre forming polymers, Classification of fibres, Properties and structure of natural fibres.	9
2	Principles of fibre spinning, Melt spinning, Solution spinning, Gel spinning, Electro-spinning, Effect of process parameters of each spinning techniques on structure and properties of fibres.	8
3	Post spinning operations, Principles and effects on properties of fibres, Drawing, Heat setting, Spin finish, Texturing, Top to tow converters.	8
4	Manufacturing, properties and uses of viscose rayon, acetate rayon, polyester, polyamide, polyacrylonitrile and polypropylene fibres.	8
5	Manufacturing, properties and uses of kevlar, nomex, polyurethane, high density polyethylene fibres, bicomponent fibers, hollow fibers.	9

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	A Textbook of Fibre Science and Technology/ SP Mishra/ New Age Publication	2014
2	Fibre Materials for Advanced Technical Textiles/ T. Matsuo/ CRC Press.	2019
3	Manufactured Fibre Technology/ V.B. Gupta, V.K. Kothari/ Springer	2012

1. Subject Code: CH407

Course Title: Polymer Blends and Composites

2. Contact Hours:

L: 03 T: 01 P: 00

3. Examination Duration (Hrs.):

Theory: 03 Practical: 00

4. Relative Weight:

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits:

04

6. Semester:

ODD-VII

7. Subject Area:

DEC/GEC

8. Pre-requisite:

NIL

9. Objective:

To impart knowledge about the polymer, blends and composites to the students.

10. Details of Course

S. No.	Contents	Contact Hours
1	Polymer blends classification, Principles of polymer compatibility, Different theories of predicting compatibility, Factors governing compatibility, Compatibilizers, Property achieved by blending, Methods of blending, Characterization of blends, Commercial polyblends and their properties, Morphology of blends and its determination.	10
2	Introduction to rheology of polymer blends, Its relevance in processing, Rheology phase morphology relationships and their relevance.	8
3	Classification of composite, particulate and fibrous composite, Introduction to reinforcing material.	8
4	Properties of composites, Fabrication of continuous and short fiber composites and particulate composites, Mechanical and physical properties.	8
5	Environmental effect on composites, Test methods and applications of composites.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Polymer Blends and Composites: Chemistry and Technology/ M.N. Subramanian/ John Wiley & Sons.	2017
2	Composite Materials: Science & Engineering/ Chawla/ Springer India	2012
3	Polymer Blends and Composites/ J.A. Manson/ Springer	2012
4	Polymer composites: From nano to macro scale/ Friedrich et al/ Springer	2005

1. Subject Code: CH409

Course Title: Plant Design and Engineering

Economics

2. Contact Hours:

L: 03 T: 01 P: 00

3. Examination Duration (Hrs.):

Theory: 03 Practical: 00

4. Relative Weight:

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits:

04

6. Semester:

ODD-VII

7. Subject Area:

DEC/GEC

8. Pre-requisite:

NIL

9. Objective:

To make student aware about the basic of process design, plant location and layout and cost estimation.

10. Details of Course

S. No.	Contents	Contact Hours
1	Basis of Process Design: Steps in process development, selection of process, factors affecting process selection, Project organization, preliminary data collection, process engineering, Feasibility survey, importance of laboratory development to pilot plant, scale up methods, types flow sheet, selection of process equipment, development of process flow sheet from process information. Optimum Design and Design strategy: Basic principle of Optimum Design, general procedure for determining optimum conditions, Optimum production rate in plant.	11
2	Plant Location and Layout: Plant location and layout, factors affecting both planning and layouts, drawings of plant layout, plant elevation drawings and complex engineering flow sheet drawings; environment and safety clearances, Safety methods in plant equipment, problems in standardization and commissioning. Project scheduling, use of PERT/CPM methods. Project evaluation and assessment of project profitability.	11
3	Cost Estimation: Factors affecting investment and production costs, Capital investments – fixed investments and working capital. Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimation capital investment. Estimation of total product cost. Different costs involved in the total product for a typical chemical process plant.	10
4	Cash flow statement, discounted cash flow, pay-back period, breakeven analysis, introduction to market survey, Balance sheet and income statement, minimum economics plant capacity, technological obsolescence, need for expansion and diversification, concept to marginal additional investment, role of research and development, Indian chemical industry, current state and trends.	10

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
--------	---------------------------------	------------------------------

1	Plant Design and Economics for Chemical Engineering/ Peters & Timmerhaus/ McGraw Hill	1991
2	Engineering Economics and Economic Design for Process Engineers/ T. Brown/ CRC Press.	2016
3	Chemical Engineering Design, 2 nd Ed/ Sinnott, Elsevier	2012
4	Process Engineering Economics/ Couper/ CRC Press	2003

1. Subject Code: **CH411** Course Title: **Advance Mass Transfer Operations**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-VII
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To impart knowledge about advance mass transport phenomena.
10. Details of Course:

S. No.	Contents	Contact Hours
1	Interphase mass transfer for multicomponent fluids in laminar and turbulent flows, Interfacial turbulence and Marangoni effects	6
2	Stefan-Maxwell approach for multicomponent mass transfer, Multicomponent distillation; Determination of key components at minimum reflux ratio by the method of Shiras, et al. Rigorous methods of Lewis-Matheson, Thiele-Geddes, bubble point, sum rates method, Naphthali-Sandholm method, residue maps.	10
3	Azeotropic and extractive distillation; stage wise calculations for multicomponent with multiple feed streams	8
4	Liquid-liquid extraction; stage wise calculations for multicomponent with multiple feed streams using reflux and mixed solvents. Liquid-liquid extraction with chemical reaction	8
5	Multicomponent gas absorption: Horton-Franklin method, Edmister method. Mass transfer in gas absorption with and without chemical reaction, model solutions by Dankwerts; Brian; Perry and Pigford.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Mass-transfer Operations/ R.E. Treybal/ McGraw-Hill	2017
2	Advanced Topics in Mass Transfer/ M. El-Amin/ BoD – Books on Demand	2011

3	Multicomponent Mass Transfer/ Ross Taylor, R. Krishna/ John Wiley & Sons.	2016
4.	Advanced Heat and Mass Transfer/ Amir Faghri, Yuwen Zhang, John R. Howell/ Global Digital Press.	2010

1. Subject Code: **CH413** Course Title: **Biochemical Engineering**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-VII
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To apply the chemical engineering principles in biological systems.

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction to Biochemical Engineering: Comparative study of chemical and biochemical processes, Basic concepts of microbiology. Sterilization: Sterilization of air and medium; sterilization of fermentor, thermal death kinetics of microorganisms.	9
2	Biochemical Kinetics: Enzyme Kinetics with one or two substrates, modulation and regulation of enzyme activity, enzyme reactions in heterogeneous systems, Immobilized enzyme technology, Industrial application of enzymes.	9
3	Microbial Fermentation Kinetics: Fermentation and its classification, Growth-cycle phases (for batch cultivation), Continuous culture, Biomass production in cell culture, Mathematical modeling of batch growth, Product synthesis kinetics, Overall kinetics and thermal death kinetics of cells and spores, Analysis of multiple interacting microbial population.	8
4	Bioreactors: Classification and characterization of different bioreactors e.g. batch and continuous, mechanically and non-mechanically agitated, CST type, tower, continuous, rotating, anaerobic etc., Design and analysis of Bioreactors - CSTR and Air Lift Reactor, Scale up considerations of bioprocesses.	9
5	Transport Phenomenon in Bioprocess Systems: Agitation and aeration-gas-liquid mass transfer, oxygen transfer rates, determination of k_La , Heat balance and heat transfer correlations.	7

	Commercial production of bioproducts: Concept of primary and secondary metabolites, Production processes for yeast biomass, antibiotics, alcoholic beverages and other products.	
--	--	--

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Bioprocess Engineering: Basic Concepts/ Shuler M., Kargi F./ PHI	2012
2	Biochemical Engineering: A Textbook for Engineers, Chemists and Biologists/ S. Katoh, J. Horiuchi, F. Yoshida/ John Wiley & Sons.	2015
3	Biochemical Engineering Fundamentals/ Bailey J.E., Ollis D.F/ McGraw Hill, New York	2016
4.	Biochemical Engineering: An Introductory Textbook/ D. Das, D. Da/ CRC Press	2019

- | | |
|---------------------------------|---|
| 1. Subject Code: CH415 | Course Title: Rocket Propulsion and Explosives |
| 2. Contact Hours: | L: 03 T: 01 P: 00 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | ODD-VII |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To impart knowledge about the propulsion, propellant, and explosives. |

10. Details of Course

S. No.	Contents	Contact Hours
1	Concepts of propulsion, Fundamentals of Rocket Propulsion: Impulse, thrust, Energy efficiencies and Effective exhaust velocity, typical Performance values.	8
2	Propellants, Classification and Ingredients; Oxidizers and fuels; Selection criteria for oxidizers and fuels.	8
3	Explosives and High energy molecules, Energetic materials, Classification, precautions during storage.	9
4	Plastic based explosives, Advantages, Binders, Insults, Composition C-4; Semtex and related explosives	8
5	Plastic based explosive detectors, Fluorescing polymer; Portable Plastic Explosives Detector; Plastic Explosives for the Purpose of Detection; Anatomy of Explosives, Detection Equipment.	9

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Rocket Propulsion Elements, 8 th Ed/ Sutton & Biblarz/ Wiley	2010
2	Propellants and Explosives: Thermochemical Aspects of Combustion/ Naminosuke Kubota/ f John Wiley & Sons.	2015
3	Rocket Propulsion/ K. Ramamurthi/ Macmillan Publishers.	2010
4	Science and Technology of Solid Rocket Propellants/ H. Singh, H. Shekhar/ Darbhanga	2005

1. Subject Code: **CH417**

Course Title: **Polymer Waste Management**

2. Contact Hours:

L: 03 T: 01 P: 00

3. Examination Duration (Hrs.):

Theory: 03 Practical: 00

4. Relative Weight:

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits:

04

6. Semester:

ODD-VII

7. Subject Area:

DEC/GEC

8. Pre-requisite:

NIL

9. Objective:

To impart knowledge about polymer waste and their management.

10. Details of Course

S. No.	Contents	Contact Hours
1	Polymer and Plastics Waste: Definition of plastics waste and the associated problems, Identification, collection methods and separation. Integrated waste management – source reduction, recycling, energy recovering process through thermal and biological destruction, Land filling and composting.	8
2	Plastics waste management: Source reduction, reuse, repair, recycling, and incineration with examples. Plastics recycling: Classification, Code of practice, Primary, secondary, territory and quaternary recycling with examples, Waste plastics as fillers.	8
3	Recycling and degradation of plastics: Recycling and sustainability correlation, Basic principles and recovery, recycling and resource conservation.	9
4	Recycling of plastics by surface refurbishing, Application of a coating, polishing, Plastics, Environmental and Thermal ageing, Chemical degradation, Wear and erosion, Biodegradable plastics – an overview.	9
5	Environmental issues, policies and legislation in India.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Plastics Recycling – Products and Processes/ Ehrig (Ed.)/ Hanser Publication	1993
2	Recycling and recovery of plastics/ Brandrup/ Hanser Publishers, New York	1996
3	Handbook of Plastics Recycling/ By Francesco La Mantia/ Rapra Tech Ltd	2002
4	Introduction to Plastics Recycling/ By Vannessa Goodship/ Rapra Tech Ltd	2007

1. Subject Code: **CH419** Course Title: **Computational Fluid Dynamics**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-VII
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To make student aware about the concepts of computational fluid dynamics and its application in chemical engineering.

10. Details of Course

S. No.	Contents	Contact Hours
1	Conservation equations for mass, momentum, energy and chemical species; turbulence closure models; heat and mass transfer models; Wellposedness and boundary conditions.	08
2	Computations fluid dynamics concepts: discretisation, accuracy, consistency, stability and convergence; Lax's equivalence theorem; analysis for consistency; analysis for stability; template for the solution of a scalar transport equation	08
3	Solution of Navier-Stokes equations: methods for compressible flow; need for special methods for incompressible flows; artificial compressibility method; stream function-vorticity method; pressure equation method; the pressure correction approach	10
4	Solution of discretized equations: direct methods; classical iterative methods; advanced iterative methods	08
5	Grid generation: structure grid generation; unstructured grid generation	08

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Computational fluid mechanics and heat transfer/ R.H. Fletcher, J.C. Tannehill, D.A. Anderson/ CRC Press	2012
2	Numerical computation of internal and external flows: The fundamentals of computational fluid dynamics/ C. Hirsch/ Butterworth-Heinemann	2007
3	An introduction to computational fluid dynamics: The finite volume method/ H.K. Versteeg, W. Malalasekera/ Pearson Education	2007

1. Subject Code: **CH421** Course Title: **Polymer Reaction Engineering**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-VII
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To familiarize the students with kinetics of polymerization.

10. Details of Course

S. No.	Contents	Contact Hours
1	Concepts of polymer reaction engineering, Fundamental concepts, Study of molecular weight distribution, Distinctive features of polymers and polymerization reactors, Changes in viscosity, density and rate constant with conversion.	10
2	Kinetics of polymerization, MW/MWD obtained for chain-growth, step-growth polymerization in batch reactor, Plug-flow reactor and continuous stirred tank reactor, kinetic studies of cationic, anionic and free radical polymerization reactions, Ziegler-Natta catalyst in stereo-regular polymerization, kinetics mechanism in heterogeneous and stereo-regular polymerization reactions, rates of Ziegler-Natta polymerization, average chain length of polymer in stereo-regular polymerization	10
3	Kinetics of emulsion and suspension polymerization, Introduction to bulk, solution, suspension and emulsion polymerization techniques, aqueous emulsifier solution, kinetic aspects of suspension and emulsion polymerization (Smith-Ewart Model), determination of total number of particles, molecular weight in emulsion polymerization, emulsion polymerization in homogenous CSTR, kinetics of dispersion polymerization.	11
4	Kinetics at High Degree of Conversion, Verification of the kinetic model and the gel effect in radical polymerization, equilibrium of radical	11

	polymerization, temperature effects in radical polymerization, role of inter phase mass transfer in the selection and the design of polymerization reactor (especially step-growth polymerization reactors), diffusion effects in Ziegler-Natta polymerization and metallocene catalyst for olefin polymerization.	
--	--	--

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Fundamentals of Polymer Engineering/ Kumar and Gupta/ Marcel Dekker.	2013
2	Modeling and Simulation in Polymer Reaction Engineering: A Modular Approach/ K. Hungenberg, M. Wulkow/ John Wiley & Sons	2018
3	Polymer Reactor Engineering/ C. McGreavy/ Springer	2013

1. Subject Code: **CH423**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-VII
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To impart knowledge about optimization, related algorithms etc to the students.
10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction: Engineering application of optimization, Design variables, constraints, objective function, variable bounds, statement and formulation of an optimization problem, Examples of chemical engineering, Optimization problems, classification of optimization problems, different optimization algorithms.	9
2	Optimal Point: Local optimal point, global optimal point and inflection point. Single variable, optimization techniques: Optimality criterion; Bracketing method (Bounding phase method); Region elimination methods (Internal halving method, Golden section search method); Point estimation method (successive quadratic estimation methods); Root finding using optimization techniques.	9
3	Multivariable Optimization Techniques: Optimality criterion; Unidirectional search method; Direct search method (Hooke-Jeeves Pattern Search method, Powell's conjugate direction method); Gradient-based methods (Steepest descent method, Newton's method, Marquardt's methods)	9

4	Constrained Optimization Algorithms: a. Kuhn - Tucker conditions b. Transformation method (penalty function method) c. Direct search for constrained minimization (variable elimination method, complex search method.)	8
5	Programming: Linear programming problems, Simplex method of linear Programming technique; Quadratic Programming.	7

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Optimization for Engineering Design: Algorithms and Examples/ Deb/ PHI	2012
2	Optimization of Chemical processes/ Edgar & Himmelblau/ McGraw Hill	2001
3	Process Optimization with Applications to Metallurgy & Chemical Engineering/ Ray & Szekey/ Wiley	1973
5.	Multi-objective Optimization: Techniques And Applications In Chemical/ G.P. Rangaiah/ World Scientific.	2016
6.	Engineering Optimization: Theory and Practice/ S.S. Rao/ John Wiley & Sons	2019

- | | |
|---------------------------------|---|
| 1. Subject Code: CH425 | Course Title: Application of Polymers in Biomedical |
| 2. Contact Hours: | L: 03 T: 01 P: 00 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | ODD-VII |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To impart knowledge about bio-polymers, applications of polymers in biomedical fields |
| 10. Details of Course: | |

S. No.	Contents	Contact Hours
1	Natural polymers, synthetic polymers, biopolymers, biocompatibility of synthetic polymers. General Principles and properties of biomaterials, biofluids, cells, tissue and organs,	7
2	Properties of implant polymers. Biomedical applications of water soluble polymers, Hard tissue prosthesis, bone prosthesis, bone cement, soft tissue prosthesis, hydrogels, contact and intraocular lenses, wound dressing and sutures, organ repair, tissue engineering,	11
3	Polymer in drug delivery, gene therapy, synthetic gene delivery to cell, applications of polymers in specific biomedical uses/devises like	8

	syringe, catheters, hemodialysis, hemofiltration, artificial muscles/ soft actuators	
4	Interface of polymers and biometrics, contraceptives based on polymers, Nano biomedical and molecular sensors.	8
5	Biosensors like glucose biosensor/ cholesterol/ urea and DNA biosensor, transducer, bioprocess monitoring and control, nano devices for early detection of different diseases.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Advanced Functional Polymers for Biomedical Applications/ M. Mozafari, N.P.S. Chauhan/ Elsevier	2019
2	Biomedical Polymers/ Jenkin/ CRC Press	2007
3	Bioresorbable Polymers for Biomedical Applications/ G. Perale, J. Hilborn/ Woodhead Publishing	2016
4	Biomedical Applications of Polymeric Materials and Composites/ Raju Francis, D. Sakthi Kumar/ John Wiley & Sons. Copyright.	2016
5	Introduction to Biosensors: From Electric Circuits to Immunosensors/ Jeong-Yeol Yoon/ Springer.	2016

1. Subject Code: **CH427**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: ODD-VII
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To familiarize students with combustion, fuels and their thermodynamic studies.
10. Details of Course

S. No.	Contents	Contact Hours
1	Historical perspective of combustion science, perspective of fuels and combustion technology; Types and general characteristics of fuels, proximate and ultimate analysis of fuels.	10

	Moisture and heating value determination: gross and net heating values, calorimetry, DuLong's formula for HV estimation, Flue gas analysis, Orsat apparatus.	
2	Classification of fuels; Solid fuels: Peat, coal, biomass, wood waste, refuse derived solid fuel, testing of solid fuels. Bulk and apparent density storage, washability, coking and caking coals. Liquid fuels: Liquid fuel types and their characteristics, Refining, molecular structure, fuel quality, Liquefaction of solid fuels. Gaseous fuels: Classification and characteristics.	8
3	Thermodynamics and kinetics of combustion: Properties of mixture, combustion stoichiometry, chemical energy, properties of combustion products. First law combustion calculations: adiabatic flame temperature (analytical and graphical methods), Simple second law analysis. Elementary reactions: chain reactions, pre-ignition kinetics, reaction at solid surface.	8
4	Combustion of solid fuels; Drying, Devolatilization, Char combustion, Fixed bed combustion, Suspension burning, Fluidized bed combustion.	6
5	Combustion of liquid and gaseous fuels; Spray formation and droplet behaviour, Oil fired furnace combustion, Direct and indirect injection combustion in IC engines, Energy balance and furnace efficiency, gas burner types: pulse combustion furnace, Premixed charge engine combustion, Detonation of gaseous mixtures..	10

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Fundamentals of Combustion Engineering/ A. Mukhopadhyay, S. Sen/ CRC Press.	2019
2	Combustion science and Engineering/ Annamalai and Puri/ CRC Press	2007
3	Fuels and Combustion, 2 nd Ed/ Sarkar/ Orient Longman	2003
4	Combustion Engineering and Gas Utilisation/ British Gas /Routledge.	2012

1. Subject Code: **CH429**

2. Contact Hours:

3. Examination Duration (Hrs.):

4. Relative Weight:

5. Credits:

6. Semester:

7. Subject Area:

8. Pre-requisite:

9. Objective:

10. Details of Course

Course Title: **Energy Resources**

L: 03 T: 01 P: 00

Theory: 03 Practical: 00

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

04

ODD-VII

DEC/GEC

NIL

To study various types of conventional and non-conventional energy resources including solid, liquid and gaseous fuels.

S. No.	Contents	Contact Hours
1	Energy Scenario: Indian and global, Present and future energy demands, Energy crisis, Classification of various energy sources, Renewable and non-renewable energy sources, Pattern of energy consumption	6
2	Solid Fuels: Coal: Origin, formation, analysis, classification, washing and carbonization, Treatment of coal gas, Recovery of chemicals from coal tar, Coal gasification, Liquid fuel synthesis from coal, Carbonization of coal, Briquetting of fines.	8
3	Liquid and Gaseous Fuels: Crude petroleum, Physical processing of crude petroleum, Fuels from petroleum, Storage and handling of liquid fuels, Natural and liquefied petroleum gases, Gas hydrates, Gasification of liquid fuels, Carbureted water gas.	10
4	Fuel Characterization: Viscosity, Viscosity index, Flash point, Cloud point, Pour point, Fire point, Smoke point and Char value, Carbon residue, Octane number, Cetane number, Aniline point and Performance number, Acid value, ASTM distillation, Calorific value, Proximate and ultimate analysis.	10
5	Alternate Energy Sources: Solar energy: Radiation measurement, applications and types of collectors and storage, Wind power, Geothermal energy, Tidal energy, Nuclear power, Fuel cells, Biogas, Biomass..	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Fuels and Fuel Technology/ W. Francis/ Elsevier	2016
2	Energy Resources Around the World/ S. Beres/ Benchmark Education Company	2011
3	Fuel Solid, Liquid and Gases/ J.S.S. Brame and J.G. King/ Edward Arnold	2004
4	Fundamentals and Practices in Colouration of Textiles, Second Edition/ J N Chakraborty/ Woodhead Publishing.	2014

1. Subject Code: **CH431**
2. Contact Hours:
3. Examination Duration (Hrs.):
4. Relative Weight:
5. Credits:
6. Semester:
7. Subject Area:
8. Pre-requisite:
9. Objective:

Course Title: **Membrane Technology**

L: 03 T: 01 P: 00

Theory: 03 Practical: 00

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
04

ODD-VII

DEC/GEC

NIL

To make student aware about the theory, principle and applications of membrane.

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction of different types of membrane based processes, classification of membrane processes based on driving force, pore size, application and types of membranes used. Membrane synthesis of organic and inorganic membranes.	8
2	Reverse osmosis process, concept of concentration polarization, film theory for concentration polarization, solution diffusion model and Non-equilibrium thermodynamics based models, Membrane used and applications. Membrane modules and its classifications.	8
3	Liquid-Liquid membranes, classification, applications, different transport mechanism in liquid membrane transport, Electro-dialysis process, membranes, classification, applications, limiting current, transport number, bipolar membranes and its applications.	8
4	Ultrafiltration and nanofiltration process, application, classification, pore size of membrane, mathematical modelling based on solution diffusion and pore flow model, membrane fouling, limiting flux, characteristics of membranes.	8
5	Gas separation and pervaporation process, application, membrane characteristics, mathematical modelling New membrane based process and other applications: Forward Osmosis, Pressure Retarded Osmosis, Membrane Contractor, Membrane Reactors	10

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Basic Principles of Membrane Technology/ M. Mulder/ Springer	2012
2	Chemical Process: Design and Integration/ Smith/ Wiley	2005
3	Synthetic Polymer Membranes/ Khulbe et al/ Springer	2008
4	Membrane Technology & Applications, Baker, Wiley Blackwell	2012

Departmental Elective Courses

8th Semester

Elective VII and Elective VIII

- | | |
|---------------------------------|--|
| 1. Subject Code: CH404 | Course Title: Fuel Cell Technology |
| 2. Contact Hours: | L: 03 T: 01 P: 00 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-VIII |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To impart knowledge about the properties, applications and components of fuel cells. |
| 10. Details of Course | |

S. No.	Contents	Contact Hours
1	Fuel cells, Working and types of fuel cell, Low, medium and high temperature fuel cell, Liquid and methanol types, Proton exchange membrane fuel cell, Solid oxide, Hydrogen fuel cells, Thermodynamics and electrochemical kinetics of fuel cells, Fuel cell reaction kinetics, Electrode kinetics.	9
2	Fuel cells for automotive applications, Technology advances in fuel cell vehicle systems, Onboard hydrogen storage, Liquid hydrogen and compressed hydrogen, Metal hydrides, Fuel cell control system, Alkaline fuel cell.	9
3	Electrode assembly components, Fuel cell stack, Bi-polar plate, Humidifiers and cooling plates, Fuel cell performance characteristics, Current/voltage, Voltage efficiency and Power density, Ohmic resistance, Kinetic performance, Mass transfer effects.	8
4	Hydrogen, Its merit as a fuel, Applications, Hydrogen production methods, Production from fossil fuels, Electrolysis, Thermal decomposition, Photochemical and Photo-catalytic methods, Hydrogen storage methods, Metal hydrides, metallic alloy hydrides, carbon nano-tubes, sea as source of deuterium, Hydrogen storage technology, pressure cylinders, liquid hydrogen, metal hydrides, carbon fibers, reformer technology, steam reforming, partial oxidation, auto thermal reforming, CO removal.	9
5	Fuel cycle analysis, Application to fuel cell and other competing technologies like battery powered vehicles, si-engine fueled by natural gas and hydrogen and hybrid electric vehicle.	7

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
--------	---------------------------------	---------------------------------

1	Fuel Cells: From Fundamentals to Applications/ S. Srinivasan/ Springer.	2006
2	Hydrogen and Fuel Cells: Emerging Technologies and Applications/ B. Sørensen, G. Spazzafumo/ Academic Press	2018
3	Fuel Cells: Current Technology Challenges and Future Research Needs/ N.H. Behling/ Elsevier	2014
4	Direct Methanol Fuel Cell Technology/ K. Dutta/ Elsevier	2020

1. Subject Code: **CH406** Course Title: **Catalysis**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: **EVEN-VIII**
7. Subject Area: **DEC/GEC**
8. Pre-requisite: **NIL**
9. Objective: To impart knowledge about Catalysis Technology and Its application in Chemical Industries
10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to catalysis: Fundamental Concepts of Homogeneous catalysis, Fundamental Concepts of Heterogeneous catalysis, advantages and disadvantages, Theoretical bases: Theories of acid-base, Acid-base equilibrium and acidity function.	8
2	Kinetics of proton transfer reactions: Theory quantum chemistry proton transfer, Theory of the acid-base catalysis the reaction intermediates, Reactions catalyzed by acids and bases, Esterification and hydrolysis of esters, Hydrolysis of amides and acids, Acid catalysis and its industrial applications, Main industrial catalysts, Catalytic cracking, Isomerization of light alkanes.	10
3	Transition elements: Introduction, Definitions, Coordination complexes, Stereochemistry of the transition metal complex, Reactions of transition metal complexes, Notion of catalytic cycle and different types of initiation complex, Tolman rule (16-18 electrons), fundamental reactions of complex, Industrial examples Hydrogenation, asymmetric catalysis, hydrocyanation, Hydroformylation, carbonylation, relationship, Oligomerization and polymerization of olefins , Oxidation reactions.	8
4	Concepts of heterogeneous catalysis: Introduction and Definition History , catalysts and catalytic properties, general mechanism of action catalyst, Heterogeneous catalysis Area of application: reactions and catalytic processes , catalytic converter, general mechanisms: diffusion, adsorption - desorption kinetics	8

5	Catalytic Cycle: Irreversible unimolecular reaction. Irreversible bimolecular reaction, Mechanism of Langmuir- Hinshelwood: competitive adsorption and non-competitive, Adsorption mechanism Eley - Rideal	8
---	--	---

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Catalysis: An Integrated Textbook for Students/ U. Hanefeld, L. Lefferts/ John Wiley & Sons	2018
2	Homogeneous Catalysts: Activity, Stability, Deactivation/ John C. Chadwick, Rob Duchateau, Zoraida Freixa, Piet W. N. M. van Leeuwen/ Wiley	2011
3	Heterogeneous Catalysis: Fundamentals and Applications/ J. R. H. Ross/ Elsevier	2012

- | | |
|---------------------------------|---|
| 1. Subject Code: CH408 | Course Title: Speciality Polymers |
| 2. Contact Hours: | L: 03 T: 01 P: 00 |
| 3. Examination Duration (Hrs.): | Theory: 03 Practical: 00 |
| 4. Relative Weight: | CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00 |
| 5. Credits: | 04 |
| 6. Semester: | EVEN-VIII |
| 7. Subject Area: | DEC/GEC |
| 8. Pre-requisite: | NIL |
| 9. Objective: | To impart knowledge to student about special polymers and their applications. |

10. Details of Course

S. No.	Contents	Contact Hours
1	Concepts of speciality polymers, High temperature and fire resistant polymers, Applications of heat resistant polymers like polyamides, polyimides, polyquinolines, polyquinoxalines, PEEK, silicone, polysiloxane, polyphosphazenes, ladder polymer, barrier polymer, dendritic polymers, telechelic polymer, luminescent polymer.	10
2	Conducting polymers, types of conducting polymers, doping of polymeric systems, conduction mechanism, Synthesis, curing reactions, and technological applications of Polyaniline, Polyacetylene, Polypyrrole, Photo-conducting and piezoelective polymers.	10
3	Polymers in corrosion inhibition, Polymers as antistatic agents, Polymer colloids, Polymeric surfactants, Polymers in conversion and storage of solar energy.	7

4	Polymers in telecommunications and power transmission - liquid crystalline polymers, Polymer impregnated concrete ultra-high modulus fibres.	5
5	Synthesis, physical properties and applications of biomedical polymers, hydrophilic polymers and ionic polymers, Natural and synthetic biopolymers and their biomedical applications.	6
6	Recent advancements in speciality polymers.	4

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Handbook of Specialty Fluorinated Polymers: Preparation, Properties, and Application/ S. Banerjee/ Plastic Design Library	2015
2	Functional Polymers/ Bergbreiter & Martin/ Springer	2010
3	Contemporary Topics in Polymer Science/ W.J. Bailey/ Springer	2014
4	Handbook of Conducting Polymers/ Skotheim & Reynolds/ CRC Press	2007
5	Conducting Polymers/ Faris Yilmaz/ BoD – Books on Demand	2016

- Subject Code: **CH410**
 - Contact Hours:
 - Examination Duration (Hrs.):
 - Relative Weight:
 - Credits:
 - Semester:
 - Subject Area:
 - Pre-requisite:
 - Objective:
- Course Title: **Process Engineering and Design**
L: 03 T: 01 P: 00
Theory: 03 Practical: 00
CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
04
EVEN-VIII
DEC/GEC
NIL
To impart knowledge about process equipment design to the students.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Design of evaporator: Introduction, types of evaporators, methods of feeding of evaporators, general design consideration of evaporator. Design of driers: Introduction, types driers, design consideration of driers Design considerations of different types of furnaces	8
2	Process Design of Heat Exchanger: Types of Heat exchanger, process design of shell and tube heat exchanger, condenser, and reboilers.	8

3	Separation Equipments: General design considerations of cyclone separators, centrifuges, clarifiers, crystallizers, flash drums, separation equipments etc.	8
4	Design considerations of mass transfer units: Design considerations of distillation, absorption, adsorption, stripping, liquid-liquid separation columns, NTU, HTU calculations, Energy requirement calculations, design considerations of packaging materials and trays.	8
5	Design considerations of reactors, homogeneous reactors (batch reactors, mixed flow reactors, plug flow reactors), Heterogeneous reactors (Fixed bed reactors, fluidized bed reactors, slurry reactors, bubble column reactors)	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Chemical Engineers' Handbook/ R.H.Perry/ McGraw-Hill	2007
2	Introduction to Process Engineering and Design/ S.B. Thakore, B.I. Bhatt/ McGraw-Hill	2015
3	Chemical Engineering Volume 6 - Chemical Engineering Design/ J.M. Coulson and J. Richardson/ Asian Books Printers Ltd.	2005

1. Subject Code: **CH412** Course Title: **Thermoplastic Elastomers**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: EVEN-VIII
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To familiarize the students with thermoplastic elastomers, types and their properties.
10. Details of Course

S. No.	Contents	Contact Hours
1	Thermoplastic Elastomers (TPEs), Elastomers, Thermodynamics of elasticity, Thermoplastic elastomers, Classification, structure and synthesis of TPEs.	8
2	Polyolefin based thermoplastic elastomers, Synthesis, Properties, Processing and Applications, PVC based TPE-PVC/Nitrile rubber blends, PVC/PU blends, PVC/Co-polyester elastomers blends, Styrenic TPEs.	9

3	Thermoplastic polyurethane elastomers, Synthesis, Properties, Processing and Applications, Polyamide based TPE, Structure-property relationship, Thermoplastic polyether ester elastomers.	9
4	Preparation of dynamically vulcanized thermoplastic elastomer blends, Properties and applications, Synthesis of ionomeric TPE, Ionic interactions in polymer blends, Applications of ionomeric elastomers.	8
5	Secondary manufacturing processes technology of TPEs, process simulation, 3D printing, product development and testing; Recycling methods for thermoplastic elastomers. Recent developments and trends in the field of thermoplastic elastomers.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Thermoplastic Elastomers: Synthesis and Applications/ C.K. Das/ BoD – Books on Demand.	2015
2	Handbook of Thermoplastic Elastomers/ Drobny/ William Andrew Publishing, New York, USA, 2 nd Edition.	2007
3	Applied Plastic Engineering Handbook: Processing and Materials, Chapter on Thermoplastic Elastomers/ Holden, G/ Elsevier, Oxford, UK.	2011

- Subject Code: **CH414**
- Contact Hours:
- Examination Duration (Hrs.):
- Relative Weight:
- Credits:
- Semester:
- Subject Area:
- Pre-requisite:
- Objective:
- Details of Course

Course Title: **Nonwoven Technology**

L: 03 T: 01 P: 00

Theory: 03 Practical: 00

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

04

EVEN-VIII

DEC/GEC

NIL

To enable the students to learn about Non-wovens, bonding processes, finishing process etc.

S. No.	Contents	Contact Hours
1	Concepts of nonwovens, Elements of nonwovens, Fibre geometry, Structure of fibrous webs, Basic nonwoven processes and their sequences.	8
2	Staple-fibre based processes, Fibre opening and mixing processes, Staple fibre web formation processes, Carding process, Parallel-lay process, Cross-lay process, Perpendicular-lay process, Air-lay process, Wet-lay process.	8

3	Web and Mechanical bonding processes, Needle-punch and Hydro entanglement process, Principle and processes of thermal bonding, Calendar, Through-air, Infra-red, Ultrasonic and Chemical bonding processes, Chemical binders, Methods of binder applications, Saturation, Foam, Spray and Print bonding process, Methods of drying.	10
4	Polymer-extrusion based technologies, Spun bond technology, Melt-blown technology, Key process factors.	8
5	Mechanical and chemical finishes and their method of applications.	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Nonwoven/ Madhavamoorthy and Shetty/ Mahajan Publishers Pvt. Ltd.	2005
2	Handbook of Nonwovens/ S.J. Russell (Ed.)/ Woodhead Publishing, CRC Press, Washington DC.	2007
3	Nonwoven Fabrics: Raw Materials, Manufacture, Applications, Characteristics, Testing Process/ Albrecht, Fuchs and Kettelmann/ Wiley-VCH.	2003
4.	Nonwovens: Process, Structure, Properties and Applications/ T. Karthik, Prabha Karan C., R. Rathinamoorthy/ CRC Press.	2017
5.	Composite Nonwoven Materials: Structure, Properties and Applications/ Dipayan Das, Behnam Pourdeyhimi/ Elsevier.	2014

1. Subject Code: **CH416**

2. Contact Hours:

3. Examination Duration (Hrs.):

4. Relative Weight:

5. Credits:

6. Semester:

7. Subject Area:

8. Pre-requisite:

9. Objective:

10. Details of Course

Course Title: **Industrial Waste Management**

L: 03 T: 01 P: 00

Theory: 03 Practical: 00

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

04

EVEN-VIII

DEC/GEC

NIL

To make student understand about the impact on environment due to the effluents of industries.

S. No.	Contents	Contact Hours
1	Magnitude of industrial waste generation and their characteristics, Effluent standards for disposal into water bodies, sewer & land, Waste water characterization and process survey, Methods of waste reduction such as volume & strength reduction, segregation, reuse, recycle,	11

	material conservation, recovery process optimization, neutralization, equalization, proportioning and solidification.	
2	Theories of waste water treatment, Pre-treatment, Biological treatment, Advanced treatment & sludge handling.	7
3	Combined treatment of raw industrial waste with sewage, Common effluent treatment for industrial estates, Selection procedure for physical, chemical & biological methods of industrial waste treatment, Management of industrial waste from small-scale industries.	9
4	Gross polluting industries, Detailed considerations of waste produced from different industries, Nature & quantity of wastes, their characteristics, usual methods of waste management & treatment methods.	9
5	e-Wastes, Problem and solutions, Regulatory authorities, regulations and compliance.	6

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Handbook of Industrial Waste Treatment/ Woodard/ Elsevier	2011
2	Waste water microbiology 4 th Ed/ Bitton/ Wiley	2011
3	Industrial Waste: Management, Assessment and Environmental Issues/ S.N. Barton/ Nova Science Publishers	2016
4	Sustainable Industrial Design and Waste Management: Cradle-to-Cradle/ Salah El Haggag/ Academic Press	2007
5.	Industrial Waste Management/ Zander Ellis/ Larsen and Keller Education	2017

1. Subject Code: **CH418**

Course Title: **Application of Nanotechnology in Polymers**

2. Contact Hours:

L: 03 T: 01 P: 00

3. Examination Duration (Hrs.):

Theory: 03 Practical: 00

4. Relative Weight:

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits:

04

6. Semester:

EVEN-VIII

7. Subject Area:

DEC/GEC

8. Pre-requisite:

NIL

9. Objective:

To make student aware about the applications of nanomaterials in various fields.

10. Details of Course

— 89 —

S. No.	Contents	Contact Hours
1	Introduction to nanomaterials and nanocomposites, types of nanomaterials and their morphology.	5
2	Preparation, structure, properties and of nano-reinforcing agents such as nanoclays, POSS, carbon nanostructures, metals, and metal oxides nanoparticles.	10
3	Effect of factors such as loading, dispersion and distribution, influence of size, shape and diameter of nanomaterials, functionalization of nanomaterials.	10
4	Structural and morphological characterization of nanocomposites and nanomaterials.	9
5	Applications of polymeric nanocomposites, recent development of nanomaterials and nanocomposites	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/Reprint
1	Polymer Nanocomposites: Synthesis, Applications and Research/ H. Thompson/ Nova Science Publishers	2017
2	Nanoscience: Nanotechnologies and Nanophysics/ Dupas, Houdy, Lahmani/ Springer-Verlag Berlin Heidelberg	2007
3	Nanostructured Materials and Nanotechnology/ H.S. Nalwa/ Academic Press	2002
4	A Textbook of Nanoscience and Nanotechnology/ Pradeep/ Tata McGraw Hill Education Pvt. Ltd.	2012
5	Advances in Polymer Nanocomposites: Types and Applications/ F. Gao/ Elsevier	2012

1. Subject Code: **CH420**

2. Contact Hours:

3. Examination Duration (Hrs.):

4. Relative Weight:

5. Credits:

6. Semester:

7. Subject Area:

8. Pre-requisite:

9. Objective:

Course Title: **Inorganic Polymers**

L: 03 T: 01 P: 00

Theory: 03 Practical: 00

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

04

EVEN-VIII

DEC/GEC

NIL

To familiarize the students about synthesis, physical and chemical properties and applications of inorganic polymers.

10. Details of Course

S. No.	Contents	Contact Hours
--------	----------	---------------

1	Introduction, Types of inorganic polymers and their special characteristics.	5
2	Characterization of inorganic polymers, Molecular weights, Molecular weight distributions, Chain statistics, Solubility considerations, Crystallinity, Transitions, Spectroscopy, Mechanical properties.	9
3	Polyphosphazenes: Synthesis, Ring opening polymerization, Mechanism, Structure-property relationships; Advanced elastomeric, Fibres, and Film forming, Polyphosphazenes, Polyphosphazenes as biomedical materials, Organometallic polyphosphazenes, Liquid crystalline and high refractive index polymers, Polycarbophosphazenes and polythiophosphazenes.	11
4	Polysilanes and related polymers: Introduction, Synthesis and Chemical modification of polysilanes, Physical properties of polysilanes, Electronic properties and conformations, Photo-degradation of polysilanes, Structure of polysilanes, Technology of polysilanes.	10
5	Miscellaneous inorganic polymers: Boranes, Polymers containing sulfur and nitrogen – properties and applications.	7

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Inorganic Polymers, Second Edition/ Mark, Allcock and West/ Oxford	2005
2	Smart Inorganic Polymers: Synthesis, Properties, and Emerging Applications/ E. Hey-Hawkins, M. Hissler/ John Wiley & Sons	2019
3	Inorganic Polymers/ G. R. Chatwal/ Himalaya Publishing House	2013
4	Inorganic Polymers/ Saxena/ Discovery Publishing House	2007

1. Subject Code: **CH422**

2. Contact Hours:

3. Examination Duration (Hrs.):

4. Relative Weight:

5. Credits:

6. Semester:

7. Subject Area:

8. Pre-requisite:

9. Objective:

10. Details of Course

Course Title: **Pharmaceutical Technology**

L: 03 T: 01 P: 00

Theory: 03 Practical: 00

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

04

EVEN-VIII

DEC/GEC

NIL

To impart knowledge about the design, development, applications and packaging of pharmaceutical compounds.

S. No.	Contents	Contact Hours
1	Drug discovery process and drug design: Introduction to drug discovery, Various stages in the process of drug design and molecular discovery to commercialization, Target selection, Drug receptor interaction, Drug action theories, Synthetic methods, Screening approaches, PK & PD, ADMET, Various phases of clinical trials.	10
2	Process technology for drugs and intermediates: Manufacturing processes for drugs and their comparative study, Optimization of organic reactions and processes and scale up, Development techniques for safe process design, Unit operations posing particular hazards during development, Chemical hazards assessment, Process control consideration and safety critical systems, GMP in chemical development.	10
3	Drug delivery systems: Conventional and recent pharmaceutical dosage forms and drug delivery systems, Polymers in Drug delivery modules, Radio pharmaceuticals.	8
4	Pharmaceutical packaging technology: Introduction to Packaging, Classification of packaging, Essential requirements, Functions of packaging, significance of pharma packaging, Properties of ideal package, Packaging formats and materials in pharma industry, New trends in the pharmaceutical packaging.	8
5	Validation and Regulatory requirements: CGMP and Quality assurance, Process, product validation and quality audits, New drug application, generic products, DPCO/NPPA, drugs and cosmetics act and rules including licensing intermediates industry.	6

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Foye's Principles of Medicinal Chemistry/D.A. Williams, 7 th Edition.	2012
2	Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry/ John M. Beale, Jr., John H. Block, Twelfth edition	2011
3	Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Howard C. Ansel, 9 th Edition,	2011

1. Subject Code: **CH424**

Course Title: **Safety & Hazards in Chemical Industries**

2. Contact Hours:

L: 03 T: 01 P: 00

3. Examination Duration (Hrs.):

Theory: 03 Practical: 00

4. Relative Weight:

CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
04

5. Credits:

EVEN-VIII

6. Semester:

DEC/GEC

7. Subject Area:

NIL

8. Pre-requisite:

9. Objective:

To make student aware about the safety aspects in chemical industries.

10. Details of Course

S. No.	Contents	Contact Hours
1	Plant safety and safety regulations, Safety in chemical & polymer industries, Origin of process hazards, Laws, Codes, Standards, Case histories, Criteria for setting & layout of chemical plant, Factories Act and Safety Regulations.	9
2	Plant hazards such as Fire, Chemicals, Explosion, Electrical, Mechanical, Radiation and Noise, Control, precautions & prevention, Safety measures in plants.	8
3	Storage and transportation of chemicals, Characteristics of chemicals with special reference to safe storage & handling, Layout of storage, Various modes of transport and safety precautions in transportation of different types of chemicals.	5
4	Risk management principles, Risk analysis techniques, Hazard & operability studies, Hazard analysis, Fault tree analysis, Consequence analysis, Human error analysis, Accident error analysis, Economics of risk management.	10
5	Safety Audit, Procedure for safety auditing, Audit report, Safety report.	6
6	Safety training, Emergency planning and disaster management.	4

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Safety and Hazards Management in Chemical Industries/ Vyas/ Atlantic.	2013
2	Chemical Hazards and Safety, 2 nd Ed/ Dawande/ Denett & Co.	2012
3	Loss Prevention in the Process Industries/ Lees/ Butterworth-Heinemann	2014
4	Industrial Safety Handbook/ William & Handley/ McGraw Hill.	-

1. Subject Code: **CH426** Course Title: **Biofuel Engineering**
 2. Contact Hours: L: 03 T: 01 P: 00
 3. Examination Duration (Hrs.): Theory: 03 Practical: 00
 4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
 5. Credits: 04
 6. Semester: EVEN-VIII
 7. Subject Area: DEC/GEC
 8. Pre-requisite: NIL
 9. Objective: To impart knowledge about the biofuels, biofuels production, applications and their environmental effects

10. Details of Course

S. No.	Contents	Contact Hours
1	Generation of biofuels – Development of biological conversion technologies – Integration of biofuels into biorefineries – Energy security and supply – Environmental sustainability of biofuels -Economic sustainability of biofuels. Photosynthesis for Biofuels, Types of biomass and available resources, Lignocellulosic biomass composition and characterizations	8
2	Pyrolysis, bio-oil upgradation, and biochar, Biomass gasification followed by Fischer-Tropsch synthesis for liquid fuels, Hydrothermal (sub- and supercritical water) technology for biofuels, Biopower, co-firing, biomass torrefaction and carbonization	8
3	Biochemical Conversion Process, bioethanol production from 1st and 2nd generation biomass feedstock, Bioethanol – Properties – Feedstocks – Process technology – Pilot plant for ethanol production from lignocellulosic feedstock – Environmental aspects of ethanol as a biofuel. biohydrogen, and methane,	10
4	Biodiesel – Properties – Feed stocks – Process technology – Pilot plant for Biodiesel production– Environmental aspects of biodiesel as a biofuel.	8
5	Advance biofuel technologies, Algae to biofuels and challenge, Biobased products, life cycle analysis, and water use in biofuels, Biofuels economics, policies, and future R&D	8

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Biorenewable Resources: Engineering New Products from Agriculture/ R.C.Brown/ Wiley-Blackwell.	2014
2	Gasoline, Diesel and Ethanol Biofuels from Grasses and Plants/ R.B. Gupta and A. Demirbas/ Cambridge University Press	2012

3	Biofuels Engineering Process Technology/ C. Drapcho, J. Nghiem, T. Walker/ McGraw Hill Publications.	2008
---	--	------

1. Subject Code: **CH428** Course Title: **Energy Conservation and Recycling**
2. Contact Hours: L: 03 T: 01 P: 00
3. Examination Duration (Hrs.): Theory: 03 Practical: 00
4. Relative Weight: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5. Credits: 04
6. Semester: EVEN-VIII
7. Subject Area: DEC/GEC
8. Pre-requisite: NIL
9. Objective: To make student understand about the conservation of energy and energy efficiency, recycling and economics.

10. Details of Course

S. No.	Content	Contact Hours
1.	Energy Conservation, Approach and modern Techniques, Benefits, Trends.	4
2.	Techno-Economic evaluation of conservation technologies, Efficiency Improvements, Thermal Utilities, Thermic fluid heating systems, Furnaces, Heating and melting applications, Refractories, Energy conservation in energy intensive chemical and process industries like pulp and paper, cement, sugar & petrochemical, fertilizer industries.	10
3.	Sources of waste heat and its utility, Heat recovery systems (Recuperates, Regenerator, Thermal or Heat wheels, Heat pipes and Heat pumps, etc.), Efficient steam generation fluidized bed boilers, Efficient use of steam traps condensate collections and return, Steam and gas turbine, Cogeneration, Heat exchanger network synthesis, Process heat recovery and recycling.	8
4.	Energy efficiency in buildings & ECBC, Envelop heat loss and heat gain and its evaluation, Opportunities and techniques for energy conservation in buildings, Adoption to sustainable resources, Process and technologies, Green buildings, Intelligent buildings, Rating of buildings.	6
5	Energy storage in conventional and non-conventional energy systems, Technical aspects, Various forms of energy storage and Techno commercial analysis (Economical aspects) thereof.	8
6	Energy economics, Thermal energy conservation, Case studies of commercial/industrial/residential energy conservation systems and their economical analysis.	6

Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Energy Conservation and Management/ S. S. Thipse/ Alpha Science International Limited	2014

2	Energy Conservation in the Process Industries/ W.F. Kenney/ Academic Press.	2012
3	Handbook of Recycling: State-of-the-art for Practitioners, Analysts, and Scientists/ E. Worrell, M. Reuter/ Elsevier	2014
4	WEEE Recycling: Research, Development, and Policies/ A. Chagnes, G. Cote/ Elsevier.	2016

Department of Applied Physics
Delhi Technological University

List of Departmental Electives

S.No.	Elective Code	Title of Elective	Elective no.
1.	EP-305	Atomic and Molecular Physics	DEC-1,2,3
2.	EP-307	Biophysics	
3.	EP-309	Quantum Information and Computing	
4.	EP-311	Computer Networking	
5.	EP-308	Laser System and Instrumentation	DEC-4,5
6.	EP-310	Medical Physics and Physiological measurements	
7.	EP-312	Fourier optics and holography	
8.	EP-314	Instrumentation and Control	
9.	EP-316	Cosmology and Astrophysics	
10.	EP405	VLSI and FPGA design	DEC-6, 7,8,9
11.	EP407	Mobile and Satellite communication	
12.	EP-409	Information theory and coding	
13.	EP-411	Advanced Simulation Techniques in Physics	
14.	EP-413	Continuum Mechanics	
15.	EP-415	Nano Science and Technology	
16.	EP- 417	Optical Electronics	
17.	EP-419	Introduction to Automation and Motion Control	
18.	EP-421	Principles of Nuclear Engineering	
19.	EP-423	Space and Atmospheric Science-I	
20.	EP-425	Plasma Science and Technology-I	
21.	EP-4XX	Thermodynamics of Materials	

Department of Applied Physics
Delhi Technological University

IV Year: Seventh Semester

S. No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	EP401	B.Tech. Project-I	DCC	4										
2.	EP403	Training Seminar	DCC	2										
3.	EP4XX	Departmental Elective Course -6	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	25/0	20 /25	40/ 50	-
4.	EP4XX	Departmental Elective Course -7	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	25/0	20 /25	40/ 50	-
5.	EP4XX	Departmental Elective Course -8	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	25/0	20 /25	40/ 50	
6.	EP4XX	Departmental Elective Course-9	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	25/0	20 /25	40/ 50	-
		Total		22										

IV Year: Eighth Semester

S. No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	EP402	B.Tech. Project-II	DCC	8										
2.	EP4XX	Departmental Elective Course-10	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	25/0	20 /25	40/ 50	-
3.	EP4XX	Departmental Elective Course-11	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	25/0	20 /25	40/ 50	-
4.	EP4xx	Departmental Elective Course-12	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	25/0	20 /25	40/ 50	-
		Total		20										

Department of Applied Physics
Delhi Technological University

EP4XX	Mechanical and Electrical behaviour of Thin Films	viii	Materials Science & Engineering Minor
-------	---	------	---------------------------------------

Minor corrections in the name of courses (Core/ DEC) offered in B.Tech. (EP) and M.Tech. (Nano Science & Technology) courses in Academic Ordinance and Regulations 2018 and 2019. It was submitted that BoS also recommended the minor revisions in the name of few courses offered by the department and also included in the basket of the MINOR specialization proposed. The changes proposed are given below:

Existing			
Course Code	Course name	Core/ Elective	Program
EP 415	Photonics		B.Tech. (EP)
EP 308	Laser & Instrumentation		
EP 304	Fabrication & Characterization of nanostructures		
NST 6405	Microelectromechanical Systems		M.Tech. (NST)
Revised			
Course Code	Course name	Core/ Elective	Program
EP 415	Optical Electronics		B.Tech. (EP)
EP 308	Laser System & Instrumentation		
EP 304	Fabrication & Characterization of materials		
NST 6405	Micro and Nano Electromechanical Systems		M.Tech. (NST)

The Open Elective 3 credit Course in 5th semester "Physics of Engineering Materials (EP-351)" is converted to 4 credit course and included in the same semester as GEC.

Department of Applied Physics
Delhi Technological University

22.	EP-4XX	Science and Technology of Thin Films	DEC-10, 11, 12
23.	EP-4XX	Advanced Materials for Photonic Devices	
24.	EP-4XX	Advanced Characterization Techniques in Material Science	
25.	EP404	Alternative Energy Storage and Conversion Devices	
26.	EP-406	Introduction to Spintronics	
27.	EP-408	Integrated Optics	
28.	EP-410	Robotic Engineering	
29.	EP-412	Nuclear Materials for Engineering Applications	
30.	EP-414	Space and Atmospheric Science-II	
31.	EP-416	Plasma Science and Technology-II	
32.	EP-418	Digital Signal Processing	
33.	EP-420	Fuzzy Logic and Neural Networks	
34.	EP-422	Embedded Systems Design	
35.	EP-4XX	Computational Material Science	
36.	EP-4XX	Mechanical and Electrical Behaviour of Thin Films	

Summary of Proposed New DEC's and it's minor:

Course Code	DEC Titles	Sem.	Offered in Minor
EP4XX	Thermodynamics of Materials	VII	Materials Science & Engineering Minor
EP4XX	Science and Technology of Thin Films	VII	Materials Science & Engineering Minor
EP4XX	Advanced Materials for Photonic Devices	VII	Materials Science & Engineering Minor and Photonics Minor
EP4XX	Advanced characterization techniques in material Science	VII	Materials Science & Engineering Minor
EP4XX	Computational Material Science	VIII	Materials Science & Engineering Minor

Department of Applied Physics
Delhi Technological University

Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	D.R. Gaskell, Introduction to the Thermodynamics of Materials, 4th Ed., Taylor and Francis, New York, 2003.	2003
	R.T. DeHoff, Thermodynamics in Materials Science, McGrawHill, New York, 1993.	1993
	O. Kubaschewski and C.B. Alcock, Materials Thermochemistry, Pergamon Press, Oxford, 1993.	1993
2.	F.P. Incropera and D.P. DeWitt, Fundamentals of Heat and Mass Transfer, 5 th Ed., Wiley India, 2006	2006
	O. Levenspiel, Engineering Flow and Heat Exchange, Plenum Press, New York, 1984.	1984
3.	D.A. Porter and K.E. Easterling, Phase Transformations in Metals and Alloys, 2 nd Ed., Chapman and Hall, London, 1992.	1992
	A.K. Jena and M.C. Chaturvedi, Phase Transformations in Materials, Prentice Hall:Englewood Cliffs, 1992.	1992

Department of Applied Physics
Delhi Technological University

Course Details and Syllabus

- | | |
|--------------------------------|---|
| 1. Subject Code: EP4XX | Course Title: Thermodynamics of Materials |
| 2. Contact Hours: | L: 3 T: 1 P: 0 |
| 3. Examination Duration (Hrs): | Theory: 3 Practical: 0 |
| 4. Relative Weight: | CWS: 25, PRS: --, MTE: 25, ETE: 50, PRE: -- |
| 5. Credits: | 4 |
| 6. Semester: | ODD |
| 7. Subject area: | DEC/GEC |
| 8. Pre-requisite: | Basic knowledge of crystal structure and physics of solids, heat and thermodynamics |
| 9. Objective: | The main goal of this subject is to provide basic understanding of thermodynamics of material and their application |
| 10. Detail of Course: | |

S. No.	Contents	Contact Hours
1.	Laws of thermodynamics. Concepts of reversibility, internal energy, enthalpy, entropy. Maximum work, free energy. Fugacity, activity and chemical potential. Homogeneous and heterogeneous equilibria, Thermoelectric effects, such as Seebeck effect, Peltier effect and Thomson effect	10
2.	Phase rule. Properties of solutions and concepts of partial molal properties. Statistical concepts of entropy. Basics of Phase diagrams: Gibbs free energy – composition diagrams, Gibbs-Thompson effect, introduction to ternary phase diagrams.	8
3.	Three modes of heat transfer. Conduction laws, resistance, fins, transient conduction, lumped parameter systems, Heissler charts. Convection - forced and natural, Radiation and view factors, absorbing media, Seebak,	8
4.	Diffusion: steady vs non-steady states, driving force and mechanisms, Fick's first and second laws. Interstitial and substitutional diffusion, high diffusivity paths.	8
5.	Interfaces: solid-vapour, grain and phase boundaries, ledge growth, glissile interface, rate controlling step, classification of material for low, moderate and high temperature application	8
	Total	42

Delhi Technological University

- | S. No. | Contents | Contact Hours |
|--------|--|---------------|
| 1. | Introduction to Photonic Materials: Introduction to materials science, Crystalline and amorphous materials, Nanostructured materials, Crystal structures, Significance of Miller indices, Bonding in solids, Basics of photonic materials, Definitions of glassy state, glass network formers, intermediates and modifiers, Volume-Temperature diagram for glass forming liquid, Photonic Glasses, Phosphors and nanophosphors, Quantum dots. | 09 |
| 2. | Synthesis of Photonic Materials: Glass formation principles, Preparation of photonic glasses by melt quenching technique, Top down and bottom up synthesis approach, Synthesis of phosphors and nanophosphors: Solid state reaction method, Combustion synthesis, Sol-gel technique and other chemical synthesis techniques. | 08 |
| 3. | Characterization Techniques: Structural analysis, X-ray diffraction, FT-IR, Thermal characterization using DSC & TG-DTA, Microscopic techniques, Absorption: The measurement of absorption spectra using spectrophotometer, Photoluminescence Spectroscopy: The measurement of excitation and photoluminescence using spectrofluorometer, Upconversion and downconversion processes, Time resolved photoluminescence. | 08 |
| 4. | The Role of Lanthanides in Photonics: Lanthanides/Rare earth elements, Properties and significance of trivalent rare earth ions, Transition mechanism for lanthanide ions, Intraconfigurational $f-f$ transitions, Magnetic dipole transitions, Induced electric dipole transitions and Electric dipole transitions, Hypersensitive transitions, Color of lanthanide ions, radiative and non-radiative | 08 |

Department of Applied Physics
Delhi Technological University

1. Subject Code: **EP4XX** Course Title: **Science and Technology of Thin Films:**
2. Contact Hours: L: 3 T: 1 P: 0
3. Examination Duration (Hrs): Theory: 3 Practical: 0
4. Relative Weight: CWS: 25, PRS: --, MTE: 25, ETE: 50, PRE: --
5. Credits: 4
6. Semester: ODD
7. Subject area: DEC/GEC
8. Pre-requisite: Basic knowledge of instrumentation and structural dimensionality of solids
9. Objective: The main goal of this subject is to provide basic understanding of thin film and vacuum system and their application

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	Vacuum components and systems : Need for vacuum, ways to achieve vacuum, determination of vacuum, dry and vapour pumps, pressure measurement gauges, conductance and other system design considerations.	10
2.	Thin film deposition techniques: Physical and chemical vapour deposition techniques including molecular beam epitaxy, laser ablation and hot wire and microwave CVD techniques. Film contamination, cosine law of deposition, conformal coverage and line of sight deposition	8
3.	Growth of thin films: Thermodynamic and kinetic considerations of deposition of thin films by both CVD and PVD. In situ characterization of thin film deposition process	8
4.	Characterization of thin films: Different methods of thickness measurements, electrical, optical, chemical and structural property determination	8
5.	Some important applications of thin films: Hard and decorative coatings, semiconductor thin films, organic thin films.	8
	Total	42

Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Materials science of thin films, M. ohring, Academic press.	1991
2.	Vacuum deposition of thin films, L. Holland, Chapman and Hall.	1961
3.	Glow discharge processes, B. Chapman, Wiley, New York.	1980
4.	Thin film phenomena, K.. Chopra, McGraw Hill, Yew York	1969

Department of Applied Physics
Delhi Technological University

1. Subject code: EPXX Course title: Advanced Characterization Techniques in Materials Science
2. Contact Hours: L: 3 T: 0 P: 2
3. Examination Duration (Hrs): Theory: 3 Practical: 02
4. Relative Weight: CWS: 15, PRS: 15, MTE: 30, ETE: 40, PRE: --
5. Credits: 4
6. Semester: ODD
7. Subject area: DEC/GEC
8. Pre-requisite: Basic knowledge of instrumentation and structural dimensionality of solids
9. Objective: The main goal of this subject is to provide basic understanding of thin film and vacuum system and their application

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	Properties of Electromagnetic radiation, interaction of EM radiation with matter, absorption, scattering, diffraction, polarization, excitation and deexcitation. Experimental techniques and analysis of materials through X-ray scattering techniques: powder method, Laue method, crystal structure determination. Phase diagram determination; X-ray stress measurements; X-ray spectroscopy.	8
2.	Optical microscopy - light optics, microscope components, possibilities and limitations Optical microscopy; optical and vibrational spectroscopy. Outline of thermal analysis technique, description, of DTA/DSC/TGA techniques and instrumentation. Applications and case studies, IR- and Raman spectroscopy UV-Vis-IR, FTIR	10
3.	Scanning Electron Microscopy - Optics and performance of a SEM, Image interpretation, crystallographic information in a SEM, analytical microscopy. Transmission Electron microscopy - construction and operation of a TEM, electron diffraction, image interpretation.	08
4.	Experimental methods in materials properties measurements: electrical, thermal, magnetic, mechanical and optical Electrical measurement techniques: Resistivity, Polarization, Dielectric properties, electrochemical techniques (Cyclic voltametry).	08
5.	Magneto-Resistance, Vibrating Sample Magnetometer, Superconducting Quantum Interference Device, Magneto Optical Kerr Effect.	08
Total		42

Department of Applied Physics

Delhi Technological University

	relaxations, Energy transfer processes, Judd-Ofelt theory to predict excited state dynamics, Rare earth doped luminescent materials.	
5.	Applications in Photonic Materials: Rare earth lasers, Advanced materials for lasers, Rare earth doped materials for optical fibers, Generation of white light, Color conversion phosphors for LEDs, Multi-phosphor pc-LEDs, Long-persistence phosphors, Solid state lighting and Display technology, Up and Down-conversion for solar cells, other selective topics in advanced functional materials.	09
Total		42

Suggested Books

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	Handbook of Optical Materials by M.J. Weber	2003/ CRC Press
2.	An Introduction to the Optical Spectroscopy of Inorganic Solids by J. Garcia Sole, L.E. Bausa and D. Jaque	2005/ John Wiley & Sons
3.	Fundamentals of Inorganic Glasses by Arun K. Varshneya	1994/ Academic Press, Inc.
4.	Inorganic Phosphors by W.M. Yen and M.J. Weber	2004/ The CRC press Laser and Optical Science and Technology Series
5.	Luminescent Materials and Applications by Adrian Kitai	2008/ John Wiley & Sons, Ltd,
6.	Material Science and engineering: An Introduction By W. D. Callister Junior	2003/ John Wiley & Sons, Inc
7.	Handbook of Electronic and Photonic Materials by Safa Kasap and Peter capper (Eds.)	2006/Springer
8.	Handbook on the Physics and Chemistry of Rare Earths, Vol.25 by K.A. Gschneidner, Jr. and L. Eyring (Eds.)	1998/Elsevier Science B.V.

Department of Applied Physics
Delhi Technological University

1. Subject code: EPXX Course title: Computational Material Science
2. Contact Hours: L: 3 T: 0 P: 2
3. Examination Duration (Hrs): Theory: 3 Practical: 02
4. Relative Weight: CWS: 25, PRS: --, MTE: 25, ETE: 50, PRE: --
5. Credits: 4
6. Semester: ODD
7. Subject area: DEC/GEC
8. Pre-requisite: Basic knowledge of quantum mechanics.
9. Objective: The student will be able to understand the power of computer program, using ab-initio methods, to accurately predict the various material properties.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	Quantum theory and the origins of electronic structure, Periodic solids and electron bands Summary, Integration over the Brillouin zone and special points, Density of states.	08
2.	Non-interacting and Hartree–Fock approximations, The correlation hole and energy, Density functional theory methods of material simulation, Functionals for exchange and correlation.	10
3.	Quantum molecular dynamics (QMD): forces from the electrons, Car–Parrinello unified algorithm for electrons and ions, Alternative approaches to density functional QMD, Examples of simulations	08
4.	Predicting properties of matter from electronic structure–I: Electronic ground state: bonding and characteristic structures, Volume or pressure as the most fundamental variable, Elasticity: stress–strain relations, Magnetism and electron– electron interactions.	08
5.	Predicting properties of matter from electronic structure–II: Response functions: phonons, magnons, Polarization, localization, and Berry’s phases. Excitation spectra and optical properties. Surfaces, interfaces, and defects.	08
	Total	42

Suggested Books

1. Ziman: Theory of solids, Cambridg
2. Taylor and Heinonen: Quantum approach to condensed matter physics, Cambridge
3. Richard M. Martin, Electronic Structure: basic theory and practical methods, (Cambridge University Press, 2004

Department of Applied Physics
Delhi Technological University

Texts/References

1. H.H. Willard, L.L. Merritt, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, 6th Ed., C.B.S. Publishers, New Delhi, 1991.
2. Metals Handbook Vol. 9, Characterization of Materials, 10th Ed., American Soc. of Metals, Metals Park, Ohio, 1986.
3. G.A. Higgerson, Experiments in Materials Technology, Affiliated East-West Press, 1973.
4. L.C. Azzarof, Elements of X-ray Crystallography, McGraw-Hill, New York, 1968.
5. M.V. Heimendahl, Electron Microscopy of Materials-An Introduction, Academic Press, 1980.
6. Metals handbook Vol,9 "Characterisation of Materials", 10th Edition, American Society of Metals, Metals Park, OH, USA., 1986.
7. H.H. Willard, L.L. Merrit, J.A. Dean and F.A. Settle, " Instrumental Methods of analysis", 6th edition, CBS Publishers & Distributors, Delhi, 1986

Department of Applied Physics
Delhi Technological University

1. Subject Code: EPXX Course Title: Mechanical and Electrical Behaviour of Thin Films
2. Contact Hours: L: 3 T: 1 P: 0
3. Examination Duration (Hrs): Theory: 3 Practical: 00
4. Relative Weight: CWS: 25, PRS: --, MTE: 25, ETE: 50, PRE: --
5. Credits: 4
6. Semester: EVEN
7. Subject area: DEC/GEC
8. Pre-requisite: Basic knowledge of instrumentation and structural dimensionality of solids

9. Objective: The main goal of this subject is to provide basic understanding of thin film and their electrical and mechanical behaviour.

10. Detail of Course

S. No.	Contents	Contact Hours
1.	Elasticity basics: Stress and strain tensors, tensor transformations, Mohr's circle representation of stress and strain, constitutive equations. Origin of stresses in thin films: thermoelastic mismatch between film and substrate, lattice mismatch in heteroepitaxial films	10
2.	Recrystallization, phase transformation, incorporation of atoms and chemical reactions. Application of the above for designing structures with low stresses. Experimental techniques for measuring stresses/strains in thin films: Substrate curvature; Stoney's equation, methods for curvature measurement	10
3.	X-ray diffraction, nanoindentation, bulge test, 4-point bend test, and microtensile test.	08
4.	Models for high stresses, strain-hardening rates and Bauschinger effect in thin films, influence of grain size, film thickness and interfaces. Indentation	08
5.	Conductivity measurements (bulk and thin films), 2 and 4 probe measurements in metals, semiconductors and insulators. Hall effect, mobility, carrier concentration measurements, AC measurements: impedance and dielectric, Work function measurement UPS, metal-semiconductor contacts, Kelvin probe.	08
	Total	42

Texts/References

- Thin film materials: stress, defect formation and surface evolution. L. B. Freund, S. Suresh, Cambridge University Press, 2003.
- Materials Science of Thin Films. M. Ohring, Academic Press, 1992.
- Mechanical Metallurgy, G. E. Dieter, McGraw-Hill, 1986
- Peter Stallnga, Electrical Characterization of Organic Electronic Materials and Devices, Wiley, NJ, 2009
- Laszlo Solymar, Donald Walsh, Electrical Properties of Materials, Oxford University Press, 8th Ed., 2010