DELHI TECHNOLOGICAL UNIVERSITY

Minutes of 21st meeting

Academic Council

held on 11.10.2019

Shahbad Daulatpur, Bawana Road, Delhi-110042

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-IX/ **Dated :**

Minutes of the 21st meeting of the Academic Council held on 11.10.2019 at 11:00 a.m. in the Pragyan Hall, DTU.

The following members were present:

1. Prof. Yogesh Singh, Vice Chancellor, DTU.
2. Prof. S.K. Garg, Pro Vice Chancellor, DTU
3. Prof. Smriti Srivastava, Head-Division of ICE, NSIT, Delhi
4. Prof. Surendra S. Yadav, Professor of Management, IIT, Delhi
5. Prof. S.G. Deshmukh, Professor, IIT, Delhi
6. Sh. Lokesh Mehra, (FICCI nominee)
7. Prof. R.S. Mishra, Dean (Outreach & Extn. Activities)
8. Prof. Ashutosh Trivedi, Dean (IRD)
9. Prof. Samsher, Dean (Continuing Education) & Registrar, DTU
10. Prof. Vishal Verma, Dean (International Affairs)
11. Prof. S.C. Sharma, Dean Academic (PG)
12. Prof. S. Indu, Dean (Student Welfare)
13. Prof. Narendra Kumar (II), Dean (Student Discipline) & Chief Warden
14. Prof. Nirendra Dev, HOD (Civil Engg. Deptt.)
15. Prof. Vipin, HOD, Mechanical Engg. Department
16. Prof. Rinku Sharma, HOD (Deptt. of Applied Physics)
17. Prof. Jai Gopal Sharma, HOD (Bio-Technology Deptt.)
18. Prof. Sangita Kansal, HOD (Applied Mathematics Deptt.)
19. Prof. N.S. Raghava, HOD (E & C Deptt.)
20. Prof. Kapil Sharma, HOD (Deptt. of I.T.)
21. Prof. Ranganath M.S., HOD (Deptt. of Design)
22. Prof. A. Mookerjee, HOD (USME)
23. Prof. Rajni Jindal, HOD (Comp. Sc. Engg.)
24. Dr. Archana Rani, HOD (Applied Chem. Deptt.)
25. Dr. Nand Kumar, HOD (Humanities)
26. Dr. Rajan Yadav, HOD (Delhi School of Management)
27. Dr. Rajesh Rohilla, HOD (Training & Placement)
28. Prof. Narendra Kumar-I, Electrical Engg. Deptt.
29. Dr. Naokant Deo, In-charge, B.Tech (Eve.)
30. Sh. Neeraj Kumar Bhagat, Associate Professor, Electrical Engg. Deptt.
31. Dr. M. Jayasimhadri, Asstt. Prof. Applied Physics
32. Sh. Kamal Pathak, Controller of Examinations, DTU
33. Ms. Anu Agarwal, Student Representative, Special invitee
34. Mr. Rachit Goel, Student Representative, Special Invitee

Following persons have also been invited to attend the meeting:

1. Dr. Manoj Kr. Sharma, CEO, (DTU IIF)
2. Sh. R.K. Shukla, Librarian
3. Sh. D.P. Dwivedi, Consultant, Finance & Planning
4. Prof. Rajeshwari Pandey, Associate Dean (UG)
5. Prof. M.M. Tripathi, Director, IQAC
6. Prof. K.C. Tiwari, Civil Engg. Deptt.
7. Dr. Rishu Chaujar, Associate Dean, Academic (PG)

Prof. Tarun Kumar Das, Registrar, University of Delhi; Dr. Bhim Singh, Dean, Academics, IIT, Delhi; Prof. Madhusudan Singh, Dean Academic (UG); Prof. Pravir Kumar, Dean (Alumni Affairs); Prof. S.K. Singh, HOD (Environmental Engg. Deptt.) Prof. Naveen Kumar and Prof. Rakesh Kumar could not attend the meeting due to their pre-occupation.

Agenda 21.1 : Opening Remarks by the Chairperson.

Hon'ble Vice Chancellor welcomed all the members of Academic Council in its 21st meeting held on 11.10.2019 in Pragyan Hall of DTU. He informed the members that DTU Phase(II) Stage-I Project (Centrally Air-conditioned) comprises of 02 academic blocks, three hostels (one for boys and two for girls) having total capacity of 990 and state of arts facilities has been started and it is expected that all buildings will be completed within 12 to 13 months.

He further, informed that to clear the space for Phase-II buildings, 111 trees have been transplanted from the site which is a unique endeavour of the university to save the trees and we hope that the survival rate of these trees, as ensured by the agency, will be more than 95%. Thus, DTU has become front runner in this area. Hon'ble Chief Minister and Dy. Chief Minister of Delhi also visited the transplanted process and appreciated the efforts of DTU. Further, 1110 new trees are also to be planted within the university campus in a month's duration.

Vice Chancellor informed the members that DTU has been ranked at bracket of 1001+ institution in the world by Times Higher Education Ranking system. He also informed that 03 M.Sc. Programmes in the Department of Applied Physics, Applied Mathematics and Biotechnology have been started, and the response was very good. It is further informed that the number of international students admitted is substantially increased in the current academic year.

The Vice Chancellor informed the Council that NAAC Peer Team has visited for accreditation of the University and sent the score based on available infrastructure/facilities. However, we have submitted an appeal against some of the criteria and appeal has been admitted. We hope that the result will be announced soon. DTU is also applying for next phase of NBA accreditation for some of the courses.

He further informed that Outreach & Extension Activity Centre has adopted 10 schools of Government of NCT of Delhi where 50 of our students are going for motivation and teaching various subjects in these schools. The renovation activity in East Delhi Campus have been completed and the Campus is now centrally air-conditioned and 02 new MBA Programs (MBA in Family Business & Entrepreneurship and MBA in Innovation and New Venture Development) have been started from this academic year.

He also informed that the recruitment process in DTU is in progress and we have advertised around 250 posts of Assistant Professor/ Associate Professor in different departments.

Agenda 21.2 : Confirmation of the minutes of the 20th meeting of Academic Council held on 10.05.2019.

The Minutes of the 20th meeting of the Academic Council held on 10.05.2019, were circulated among all the members vide Ref. No. DTU/ORG/ AC/Meeting/01(1)/2010/Vol-IX/831-53 dated 21.05.2019, no comments have been received from any of the members.

The Academic Council confirmed the minutes of 20th AC meeting.

Agenda 21.3 : Action taken report on the decisions taken in the 20th meeting of the Academic Council.

Action Taken Report on the decisions taken in the 20th Meeting of the Academic Council held on 10.05.2019 was placed before the Academic Council.

The Academic Council took action taken report on record with following modifications:

i) **In item no. 20.18, last column is modified as – "*M.Sc. (Physics), M.Sc. (Mathematics) and M.Sc. (Biotechnology) have been started from the academic session 2019-20*".**

ii) **In item no. 20.26 (1), last column is replaced as – "*Board of Management in its 32nd meeting held on 21.06.2019 approved the number of Ph.D. fellowship equal to twice the number of faculty having Ph.D. degree. The allotment of student will be done on the basis of thrust area, interest of student and availability of faculty. Board of Management renamed the fellowship as DTU Teaching and Research Fellowship.*"**

Agenda 21.4 : 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 **59 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:

Department of Applied Chemistry

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Ms. Khushbu	2K17/Ph.D/AC/13	08.05.2019
2	Mr. Yogesh Balasaheb Khairnar	2K16/Ph.D/AC/05	31.05.2019
3	Mr. Juikar Subodh Kamalakar	2K17/Ph.D/AC/14	12.07.2019
4	Ms. Deepti Chauhan	2K18/Ph.D/AC/05	08.07.2019
5	Ms. Deepali Ahluwali	2K18/PHDAC/03	09.09.2019

Department of Applied Physics

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Mr. Prateek Sharma	2K17/Ph.D/AP/02	16.04.2019
2	Mr. Vineet Sharma	2K18/Ph.D/AP/12	16.04.2019

Department of Applied Mathematics

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Ms. Ruchika	2K17/Ph.D/AM/07	28.05.2019
2	Mr. Kartikay Khari	2K17/Ph.D/AM/02	31.05.2019
3	Mr. Ankit Sharma	2K17/Ph.D/AM/01	28.05.2019

Department of Civil Engineering

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Mr. Ashish Kumar	2K17/Ph.D/CE/19	26.04.2019
2	Mr. Rahul Kumar	2K17/Ph.D/CE/03	29.01.2019
3	Ms. Uzma Bashir Wani	2K17/Ph.D/CE/09	21.06.2018
4	Mr. Manvendra Verma	2K16/Ph.D/CE/05	27.04.2018
5	Ms. Charu Malik	2K17/Ph.D/CE/23	29.04.2019
6	Mr. Suresh Kumar Nagar	2K18/Ph.D/CE/28	05.04.2019
7	Ms. Supriya Pal	2K18/Ph.D/CE/20	04.04.2019
8	Mr. Gokaran P. Awadhiya	2K17/Ph.D/CE/13	05.08.2019
9	Mr. Indrajeet Singh	2K18/PHD/CE/14	28.08.2019
10	Mr. Ajeet	2K18/Ph.D./CE/12	09.08.2019
11	Ms. Shambalid Ahady	2K17/Ph.D/CE/29	15.05.2019
12	Mr. Jaganniwas	2K14/Ph.D/CE/15	13.05.2019

Department of CSE

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Mr. Vishal Bhargava	2K17/Ph.D/CO/11	11.07.2019
2	Mr. Lokesh jain	2K17/Ph.D/CO/10	27.11.2018
3	Mr. Nitin Sachdeva	2K17/Ph.D/CO/03	28.11.2018
4	Ms. Manisha Saini	2K17/Ph.D/CO/09	05.10.2018
5	Ms. Anshu Khurana	2K17/Ph.D/CO/02	17.09.2018
6	Ms. Shivani Pandey	2K18/Ph.D/CO/02	05.08.2019
7	Ms. Aakansha Gupta	2K18/Ph.D/CO/10	25.07.2019
8	Ms. Pratima Sharma	2K18/Ph.D/CO/01	24.06.2019
9	Ms. Shweta Meena	2K18/Ph.D/CO/06	18.06.2019
10	Ms. Vidushi	2K18/Ph.D/CO/23	03.06.2019
11	Ms. Shreya Arora	2K16/Ph.D/CO/04	31.05.2019
12	Ms. Amrita Sisodia	2K17/Ph.D/CO/01	02.05.2019
13	Ms. Garima	2K17/Ph.D/CO/05	28.11.2018
14	Ms. Tejna Khosla	2K17/Ph.D./CSE/07	03.07.2019

Department of Mechanical Engineering

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	M. Kaushalendra Kumar Singh	2K17/Ph.D/ME/20	24.04.2019
2	Mr. Gaurav Kumar	2K17/Ph.D/ME/57	31.05.2019
3	Mr. Deepak Kumar	2K17/Ph.D/ME/13	31.07.2019
4.	Mr. Mohd. Asjad Siddiqui	2K18/Ph.D/ME/17	06.08.2019

Department of Delhi School of Management

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Ms. Anjali Sisodia	2K16/Ph.D/DSM/07	16.05.2019

Department of Electronics & Communication Engineering

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Mr. Munindra	2K17/Ph.D/EC/03	24.07.2019
2	Mr. Sudarshan Kumar	2K17/Ph.D/EC/10	26.02.2019
3	Mr. Gaurav Sharma	2K14/Ph.D/EC/03	26.02.2019

Department of Biotech Engineering

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Mr. Rajkumar Chakraborty	2K18/Ph.D/BT/01	08.01.2019
2	Mr. Sunil Kumar	2K18/PHD/BT/19	05.09.2019

Department of Electrical Engineering

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Mr. Avdhesh Kumar	2K17/Ph.D/EE/04	15.04.2019
2	Ms. Rohini Sharma	2K17/Ph.D/EE/17	16.04.2019
3	Mr. Isaka J. Mwakitalima	2K18/Ph.D/EE/21	28.03.2019
4	Ms. Pankhuri Asthana	2K17/Ph.D/EE/13	08.07.2019

Department of Information Technology

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Ms. Ashima Yadav	2K17/Ph.D/IT/06	15.04.2019
2	Ms. Srishti Vashishtha	2K17/Ph.D/IT/03	21.12.2018
3	Ms. Shalini Gakhar	2K17/Ph.D/IT/09	29.06.2018
4	Ms. Swati Sharda	2K17/Ph.D/IT/01	04.08.2018
5	Mr. Rahul Gupta	2K17/Ph.D/IT/07	18.12.2018
6	Mr. Akshay Mool	2K17/Ph.D/IT/05	20.09.2018
7	Ms. Anamika Chauhan	2K17/Ph.D/IT/05	04.08.2018

Department of Environmental Engineering

Sr. No.	Name of the Candidate	Roll No	Date of SRC
1	Ms. Prerna	2K16/Ph.D/EN/04	11.04.2019
2	Maninder Kaur	2K15/Ph.D./EN/03	21.08.2019

Decision : The Academic Council approved the formal registration of 59 candidates for Ph.D. program.

Agenda 21.5 : Approval for amendments in the Ph.D. Ordinance (Fourth).

It was submitted to the Academic Council that a meeting was held on September 23, 2019 for verifying the Ph.D. ordinance (Fourth) and to make necessary amendments in the Ph.D. Ordinance (Fourth).

The following members were present in the meeting:

1. Prof. Suresh C. Sharma, Dean (Academic-PG) : Chairman
2. Dr. Rishu Chaujar, Applied Physics : Member
3. Dr. Ruchika Malhotra, CSE : Member

The ordinance was carefully verified and assessed for minor mistakes and revisions. The following are the minor amendments proposed by the committee:

S.No.	Clause/Sub - Clause No. in existing Ph.D. Ordinance	Existing Clause of Ph.D. Ordinance of DTU	Recommendations of the Committee	Effective Academic Year of Implementation
1.	R.15.2(iii)	Candidate has published minimum two research papers in SCI Indexed Journals or has produced the evidence in the form of acceptance letter. Only those publications will be counted toward the minimum condition, where the sole authors of the papers are the candidate/or candidate and supervisor(s) both. For those departments which do not have sufficient number of journals which are SCI indexed, department will prepare and publish a list of journals of high repute for the aforesaid mandatory requirements of two research papers. The list will be recommended by the DRC at the beginning of every academic year for the approval of the Vice Chancellor.	Candidate has published minimum two research papers in SCI/SCI expanded/SSCI Indexed Journals or has produced the evidence in the form of acceptance letter. Only those publications will be counted toward the minimum condition, where the sole authors of the papers are the candidate/or candidate and supervisor(s) both. For those departments which do not have sufficient number of journals which are SCI/SCI expanded/SSCI indexed, department will prepare and publish a list of journals of high repute for the aforesaid mandatory requirements of two research papers. The list will be recommended by the DRC at the beginning of every academic year for the approval of the Vice Chancellor.	2016-17
2.	R.13.1	Holding of Pre-Ph.D. seminar before the SRC is an essential requirement prior to the Ph.D. candidate submits his synopsis. On completion of the research work, the candidate shall submit to DRC through supervisor(s), 8 copies of the synopsis. The DRC Chairman will forward the synopsis with its recommendations to the Dean-0PG. A panel of atleast ten experts in the area would be suggested by the Supervisor(s) and recommended by SRC while forwarding the title and synopsis of the thesis. The panel so recommended would include atleast five examiners from outside India.	Holding of Pre-Ph.D. **open** seminar before the SRC and DRC is an essential requirement prior to the Ph.D. candidate submits his synopsis, provided that the candidate has published/accepted for publication, minimum two research papers as prescribed in regulation R 15.2 (iii). The candidate shall submit to DRC through supervisor(s), 8 copies of the synopsis. **After the approval of synopsis by DRC,** the DRC Chairman will forward the synopsis with its recommendations to the Dean-PG. A panel of atleast ten experts in the area would be suggested by the Supervisor(s) and recommended by DRC while forwarding the title and synopsis of the thesis. The panel so recommended would include atleast five examiners from outside India.	2017-18

S.No	Clause/Sub - Clause No. in existing Ph.D. Ordinance	Existing Clause of Ph.D. Ordinance of DTU	Recommendations of the Committee	Effective Academic Year of Implementation
3.	R.10.2	A candidate shall be formally registered as a candidate for the Ph.D. degree after he has complied with the following: (a) has completed his course work with a minimum of B grade in each course registered. (b) has passed the comprehensive examination; and (c) has submitted a research plan duly approved by SRC.	The Ph.D candidacy of the student will be confirmed after he has complied with the following: (a) has completed his course work with a minimum of B grade in each course registered. (b) Has passed the comprehensive examination; and (c) Has submitted a research plan duly approved by SRC and recommended by DRC.	2017-18
4.	R.12(Title)	Minimum and Maximum Registration requirement	Time Period Requirement for Synopsis/Thesis submission	2017-18
5.	R.12.1	A candidate shall be required to be registered for the degree for a period of not less than two calendar years (24 months) from the date of his successful completion of comprehensive examination and acceptance of Research Plan.	The minimum period required for holding a Pre- Ph.D. Seminar and synopsis submission is two calendar years (24 months) from the date of his successful completion of comprehensive examination and acceptance of Research Plan i.e. from the date on which the Ph.D. candidacy of the student is confirmed.	2017-18

Decision : The Academic Council agreed to the amendments in the Ph.D. Ordinance (Fourth) as above and recommended the matter to be placed before the Board of Management for its approval.

Agenda 21.6 : Confirmation of admissions for Ph.D, M.Tech, MBA, EMBA and M.Sc Programmes for the Academic Year 2019-20.

It was submitted to the Academic Council that the following admissions were made in the Academic Year 2019-20 for Ph.D, M.Tech, MBA, EMBA and M.Sc programmes. The list of the admitted students for the said programmes are given below:

S.No.	Name of the Programme	Total no. of Students admitted
1.	M.Tech	325
2.	MBA	124
3.	USME (East Campus MBA)	26
4.	EMBA	49
5.	Ph.D	173
6.	MBA (Business Analytics)	22
7.	MBA (FBE)	11
8.	MBA (IEV)	16
9.	M.Sc. (Mathematics)	33
10.	M.Sc. (Bio)	35
11.	M.Sc. (Phy.)	33

Decision : The Academic Council confirmed the admissions to Ph.D., M.Tech., MBA, EMBA and M.Sc programmes during the academic year 2019-20.

Agenda 21.7 : Cancellation/Withdrawal of admissions made during the academic year 2019-20 for M.Tech, MBA, E-MBA, M.Sc and Ph.D. programmes.

It was submitted to the Academic Council that the certain admissions have been withdrawn during the academic year 2019-20 for M.Tech., MBA, EMBA, M.Sc and Ph.D programmes. The list of the students who cancelled their registration is given below:

M.Tech/MBA/M.Sc. withdrawal details 2019-20.			
S.NO	Roll No.	Name	Withdrawal date
1	2K19/BME/01	Jasmine Pruthi	13.08.2019
2	2K19/STE/01	Manik Uppal	09.08.2019
3	2K19/BIO/05	Lakshmi Aswini Javvadi	23.07.2019
4	2K19/HFE/05	Asmita Pandey	14.08.2019
5	2K19/HFE/08	Ashu Singhal	12.08.2019
6	2K19/CSE/18	Raghav Gupta	07.08.2019
7	2K19/SWE/08	Naresh Kumar	04.09.2019
8	2K19/VLS/15	Saptarshi Rudra	29.08.2019

9	2K19/VLS/502	Anjana Yadav	29.08.2019
10	2K19/STE/502	Pankaj Narang	08.08.2019
11	2K19/MSCMAT/22	Mr. Vishal Pal	12.09.2019
12	2K19/MSCMAT/32	Ms. Mani Aggarwal	25.08.2019
13	2K19/DMBA/45	Krishna Lahoti	27.08.2019
14	2K19/BMBA/10	Mansi Gupta	08.07.2019
15	2K19/BMBA/09	Kumar Roshan	11.07.2019

Cancellation/Withdrawn of Ph.D Registration

Sr. No.	Name of the Candidate	Roll No	Name of the Department
1	Ms. Shagun	2K18/Ph.D./EN/01	Environmental Engineering
2	Ms. Vaishali	2K18/Ph.D./USME/03	USME
3	Mr. Neeraj Sharma	2K14/Ph.D./AP/06	Applied Physics
4	Mr. Saurabh Katiyar	2K19/Ph.D./EC/18	E & C Engg.

Decision : The Academic Council approved the cancellation of admissions of above mentioned students.

Agenda 21.8 : Approval for syllabus for M.Sc. (Physics) programme.

It was submitted to the Academic Council that a proposal of syllabus for M.Sc. (Physics) has been received from HoD (Applied Physics), DTU duly approved by their Board of Studies. The detailed syllabus with respect to the courses offered in the 2nd year (3rd and 4th semester) for the postgraduate M.Sc. (Physics) programme started from the current academic session, 2019-20. The revised scheme for the elective courses in 3rd and 4th semester was placed before the Academic Council.

Syllabus for M.Sc. (Physics) 3rd and 4th semester is placed as ***Annexure at pages from 01 to 26.***

Decision : The Academic Council constituted a committee of the following members to examine the contents of the syllabus for M.Sc. (Physics) program and authorized Vice Chancellor to accept the recommendations of the Committee:

1. **Pro Vice Chancellor - Chairperson**
2. **Prof. S.C. Sharma, Dean Academic (PG)**
3. **Prof. H.C. Taneja**
4. **HOD (Applied Physics)**
5. **HOD (Biotechnology)**
6. **HOD (Applied Mathematics)**
7. **Registrar- Member Secretary**

The Academic Council also advised the committee to submit its report within 10 days.

Agenda 21.9 : Approval for syllabus for M. Tech in Geoinformatics.

It was submitted to the Academic Council that a proposal of syllabus for M. Tech in Geoinformatics has been received from HoD (Civil), DTU duly approved by their Board of Studies. The detailed Syllabus and Scheme of both the programmes are placed in ***Annexure at pages 27 to 60.***

Decision : The Academic Council approved the proposed syllabus for M.Tech in Geoinformatics, with an advice to modify the contents of course GEO 5301 (Probability, Statistics and Information Theory in Geoinformatics) and authorized Vice Chancellor to accept the changes, if any.

Agenda 21.10 : Introduction of two new electives courses as "Data Analytics I (EKTM/EIT-11)" and "Data Analytics II (EKTM/EIT-12)" for MBA (Executive) programme at Delhi Technological University.

It was submitted to the Academic Council that the Delhi School of Management of the University intends to introduce two new elective courses namely **"Data Analytics I (EKTM/EIT-11)"** and **"Data Analytics II (EKTM/EIT-12)"** under Information Technology Management and Knowledge & Technology Management specializations of MBA (Executive) programme. These courses are industry relevant and much in demand. Also it will help the students in understanding data as it relates to business problem and enable them to create and analyse relational database concepts. The detailed revised contents of the courses are placed as ***Annexure at pages 61-62.***

Decision : The Academic Council approved the agenda with advice to mention L.T.P. in the courses and include software as applicable.

Agenda 21.11 : Approval for amendment in Criteria for renewal of granted patents- IPR policy.

It was submitted to the Academic Council that DTU faculty has 03 granted patents, 10 published patents and 03 filed patents. Every year, a heavy renewal fee is to be paid for the granted patents up to a period of 20 years whereas patents are not getting commercialized for a long time.

It was proposed that financial assistance for renewal of patent will be provided for a period of 10 years from the date of the patent and the financial assistance will only be provided beyond 10 years subject to commercialization of the patent.

Decision : The Academic Council approved the amendment in Criteria for renewal of granted patents- IPR policy and recommended to be placed before the Board of Management for its approval.

Agenda 21.12 : Approval for Ph.D curriculum of the Department of Design.

It was submitted to Academic Council that the proposal of **Ph.D course work in department of Design** has been received from HoD (Design) DTU duly approved by their BOS for approval of the Academic Council. The detailed Syllabus and Scheme of the programme are placed in ***Annexure at pages from 63 to 73.***

Decision : The Academic Council approved the Ph.D. curriculum of the Department of Design with modification in credit of Research Methodology as 4 and requirement of course work as per Ph.D. Ordinance (Fourth).

Agenda 21.13 : Approval for initiation of Master of Design program from August, 2020 onwards.

It was submitted to the Academic Council that Department of Design is planning to initiate M. Des program in three specialized areas from August 2020 onwards: -

1) Visual communication (seats offered-15, proposed)
2) Product Design (seats offered-15, proposed)
3) Interaction Design (seats offered-15, proposed)

The following faculty members will be part of the team. The team will prepare the course material and requirement of specialization & submit the draft to the Chairman, Head of the Department of Design. The tentative date for submission is 10 December, 2019 so as to call for the written test as well as interviews in time.

1) Prof. Ranganath M Singari, Head, DOD (Chairman)
2) Prof. L. K. Das, Honorary Faculty, DOD (Member)
3) Mr. Neeraj Rathee, Asst. Prof., DOD (Member)
4) Dr. Ravindra Singh, Asst. Prof., DOD (Member)
5) Mr. Naveen Rampal, External Expert (Member)
6) Mr. Gaurav Chadha, External Expert (Member)
7) Mr. Partha Pratim Das, Asst. Prof., DOD (Member, Secretary, M.Des program, DOD)

Decision : The Academic Council approved for initiation of either of one Master of Design (M.Des) program as mentioned above from August, 2020 onwards and the remaining two courses from the academic year 2021-22.

Agenda 21.14 : Approval for Guidelines for Travel Grant to Students for participating in events like Hackathon, MUN, Important Meeting etc. (other than innovative project competition).

It was submitted to the Academic Council that the committee duly constituted by Hon'ble Vice Chancellor has framed the following guidelines along with specified form for applying travel grant for participating in event like Hackathon, MUN and Important Meetings other than innovative project competition in India or abroad:

1. The Institution where the student intends to attend the event should be a reputed academic institution.

2. The University shall pay 50% of air fare, visa and registration fees subject maximum of Rs. 75,000/- per student over all for international travel and Rs. 25,000/- for national travel.

3. The financial assistance will be committed only after evaluating the request by committee consisting-

   a) Pro Vice Chancellor/VC Nominee
   b) Dean Student Welfare
   c) Head of the Department
   d) Faculty Coordinator

4. The amount will be reimbursed only after submission of a report on outcome of the event after participation.

5. Maximum number of students attending an event is limited to **two** only.

6. This facility will be given only for once during the period of course of the participant.

Total Budget: 50 lacs per year from Student Welfare Fund.

Under Budget Head: 4(4.2)- "Participation in Seminar, Conferences, workshops, Industrial Tours, Technical, Sports and Cultural Activities.

Form for applying travel grant

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Shahabad Daulatpur, Bawana Road Delhi-110042

FORMAT FOR GRANT FOR STUDENTS PARTICIPATION IN EVENT

(Hackathon, MUN, Important Meetings, Other than Innovative Projects)

1.	Name of event	
2.	Date of event and place of event	
3.	Details of Event and the procedure of selection to participate(with proof)	
4.	Details of Pervious Participation (if any)	
5.	Student Team Leader with Mobile No. & Email Id	
6.	Faculty Advisor with Mobile No. & Email Id	
7.	Travel fare visa charge if any	
8.	Funds Requested from University	
9.	Expected Outcome	

Team Leader: _____

Faculty Advisor: _____

Project No._____

***Dean Student Welfare will allot Project Number, Committee for Evaluation and Monitoring of the Project. ***

Decision : The Academic Council approved the Guidelines for travel grant to Students for participating in events like Hackathon, MUN, Important Meeting etc. with some modifications as above.

Agenda 21.15 : Approval for Guidelines for Semester Away Program for Course Work/Project Work involving mobility of DTU students (UG/PG/Ph.D) besides laying out of the modalities.

It was submitted to the Academic Council that a proposal to facilitate the students for studying at international universities for one semester is submitted by the Dean, International Affairs.

Students can do course work and/or project work at any University that is ranked in first 500 by Times Higher Education or QS ranking in last five years. The other Universities may also be considered where DTU has signed a Memorandum of Understanding under the student exchange program.

Program wise Eligibility:

U.G. programs of 4 Year duration	(i) Completed 4 Semester stay at DTU (ii) CGPA ≥ 7.0 (At the time of application) without any backlog (iii) No Disciplinary Action initiated OR should not be within the Disciplinary Action period
U.G. programs of 3 Year duration	(i) Completed 2 Semester stay at DTU (ii) CGPA ≥ 7.0 (At the time of application) without any backlog (iii) No Disciplinary Action initiated OR should not be within the Disciplinary Action period
P.G. programs of 2 Year duration	(i) Completed 2 Semester stay at DTU (ii) CGPA ≥ 7.0 (At the time of application) without any backlog (iii) No Disciplinary Action initiated OR should not be within the Disciplinary Action period

Selection of Host Institution:

Dean International Affairs (IA) DTU will be the nodal officer for selection of the host institution with the approval of Vice Chancellor

Subject Selection:

(i) Students are allowed to register equivalent credits ranging over 8 – 20 (upper and lower limits)

(ii) Student shall prepare a table showing subjects to be registered in the Host Institution and their equivalent subjects at DTU (attach the subject details), subjects at host institution can be selected against Department Electives, General Electives and Open Electives. The above Table must also list the remaining subjects of the curriculum, belonging to the semester planned under the program, along with a timeline plan for completing these remaining subjects.

(iii) Students are allowed to take courses against the quota of courses from Department Electives, General Electives and Open Electives. All the core courses should be completed within their prescribed schedule at DTU.

(iv) The equivalent subjects may be chosen from the subject list belonging to the semester planned for mobility under the program as well as to the subsequent semester of the Academic Curriculum being followed at DTU, without violating the prerequisite condition.

***Financial Support*:**

(i) Obtain a letter of Financial Support for the Program from Parents/Funding Agency.
(ii) No financial support from DTU

***Procedure*:**

(i) Submit the application to the office of Dean International Affairs (IA) in the prescribed format available on DTU website along with all the attachments.
(ii) Application Deadline : 31st July for Spring(*Even*) Semester and 31st January for Autumn (*Odd*) Semester
(iii) Dean IA will send the application to respective HoD of the departments to evaluate the courses, their equivalence and other parts of the application. The HoD may appoint a faculty coordinator for this purpose.
(iv) Dean IA will call the meeting of the Equivalence Committee to consider the applications and make recommendation.

The Equivalence Committee shall consist of

(a) Pro VC or Dean nominated by the Vice Chancellor
(b) Dean (IA) Member Secretary
(c) Dean UG
(d) Dean PG
(e) HoD of the concerned Department

The Equivalence Committee shall also decide the credit which shall be credited to students on successful completion of semester abroad.

(v) Office of International Affairs will extend the support to:
(a) Help student in formal application process,
(b) Help in identifying a mentor in the Host Institution
(c) Communicate and finalize the process of grade submission by the Host Institution and (d) May issue "No Objection Certificate (NOC)" for Visa Application.

(vi) On acceptance by the Host institution, student will formally informed by the Office of International Affairs about the exact date of the commencement of the program.
(vii) Dean IA will report the cases to the academic council.
(viii) While at the Host institution, the student will inform the Dean IA of any deviation from the approved subject list, and get the changes approved by Dean IA. Dean IA may refer the matter to Equivalence Committee, if needed.

(ix) Remain in touch with the Mentor at the Host Institution
(x) Adhere to the approved schedule for reporting back to DTU.

For doing project/research work at a Host institution the onus of finding a guide rests with the student. It also needs the concurrence of the project guide at DTU if they wish to submit their work done abroad towards their degree and get credits for it.

Miscellaneous

Special Selection Criteria	In the cases where MoU between DTU and the Host Institution limits the number of applications, the decision will be based on the CGPA, i.e. the applicant with a higher CGPA will be given preference.
Tuition Fee	(a) The student has to pay Full Fee here at DTU only if she/he is travelling to a Host Institution with which DTU has a MoU, under which the tuition fee is waived/subsidised at the Host Institution (b) The student has to pay 50% of the tuition fee (for that semester) in addition to other components of fees here at DTU if the student pays Tuition Fee at the MoU/Non-MoU Host Institution. A payment certificate from the Host Institution will be needed for the purpose of claiming the reimbursement of the said 50% tuition fee.
Hostel and Mess Fee at DTU	(a) The student need to pay Hostel Charges for the period of absence from DTU provided he/she is allowed to retain the hostel room. (b) The student need not pay Mess Charges for the period of absence from DTU

For M Tech students with AICTE/other fellowship(s):

The student may continue to draw AICTE/other fellowship if the stay is not fully funded by the Host Institution/Funding Agency.

Decision : The Academic Council approved the Semester Away Program for Course Work/Project Work involving mobility of DTU students (UG/PG/Ph.D) besides laying out of the modalities.

Agenda 21.16 : Approval for modifications in eligibility conditions for admission of International students for academic year 2020-21.

It was submitted to the Academic Council that eligibility conditions are proposed for minor modifications for International Students besides seat matrix for the academic year 2020-21. Further, essential eligibility qualifications for new M.Sc programmes are also proposed for inclusion with existing qualifications for academic year 2020-21 onwards for international students. The details are as under:

A. Modification in eligibility conditions for admission under Mode 3 (Direct Mode DTU Portal) and Mode 4 (Study in India)

Similar eligibility criterion will be applicable for admission under Mode 3 and Mode 4. ***Under these modes the requirement of passing 11th and 12th or equivalent from foreign country is mandatory.***

The merit list shall be prepared on the basis of average of percentage in (I) and (II) below:

I. Aggregate score in the subjects as per academic eligibility criterion laid on page 8.

II. SAT-II Score obtained in Physics, Mathematics and the other core subject.

B. Revised seat matrix for B.Tech Program.

Based on total no. of seats available: 2115

Discipline	M1	M2(a)	M2(b)	M3(a)	M3(b)	M4 (a)	M4 (b)
ECE	10	4	4	3	3	3	3
COE	20+1	8	8	6	6	6	6
ME	13	6	5	4	4	4	4
EE	13	6	5	4	4	4	4
PIE	3	2	1	1	1	1	1
CE	7	3	2 + 1	2	2	2	2
ENE	3	2	1	1	1	1	1
PCT	3	2	1	1	1	1	1
IT	7	3	2	2	2	2	2
BT	3	2	1	1	1	1	1
SE	7	3	2	2	2	2	2
MAM	3	2	1	1	1	1	1
EP	5	2	2	2	1	2	1
MC	7	3	2	2	2	2	2
	104+1	48	37+1	32	31	32	31
						Total	315 +2

M1 – (Direct admission of student abroad (DASA)
M2 – Indian Council for Cultural Relation (ICCR)
M3 – Direct admission through DTU Portal
M4 – Study in India

The admission for B.Tech programs shall be subjected to the limit of 20% of the total seats from one particular country in Mode 3 and Mode 4.

There is no change in number of seats for B.DES, BA (ECO), BBA, MBA, MBA (BA) and M.Tech programs. However, additional number of seats may be included with prior permission from chairmen, Academic Council.

C. Essential Academic Eligibility for Master of Science (M.Sc) Program.

The applicant must have passed qualifying degree with 55% or equivalent CGPA provided by concerned Institute/University:

I. **Mathematics:** BA/B.Sc. (Gen or Hons) with mathematics as one of main subject.
II. **Physics:** B.Sc. (Gen or Hons) with mathematics as one of main subject.
III. **Bio Technology**: B.Sc. (Gen or Hons) with biology as one of main subject.

Decision : The Academic Council approved the modifications in eligibility conditions for admission of International students for academic year 2020-21 as above and authorized Vice Chancellor to decide the number of seats in M.Sc. programs and others.

Agenda 21.17 : Matter for Ratification:

i. Criterion for award of grades for B.Tech Project-II and conditions for M.Tech Project-II.

It was submitted to the Academic Council that the following criterion has been approved by the Competent Authority for award of grades to be followed while evaluating B.Tech Project-II.

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 good 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.

Further, a maximum of 3 students will be allowed to work in a group in **B.Tech Project-II**.

The following conditions are approved by the competent authority to be followed while evaluating the **M.Tech Project-II (Research Work is excluded from the following guidelines/conditions and will have a separate evaluation scheme):**

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	Two good 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.

The above criterion is adopted for the final semester of B.Tech and M.Tech programmes w.e.f. academic session 2019-2020. Earlier letter no. DTU/IRD/002/2019/1439 dated: 23.07.2019 is withdrawn.

The Academic Council ratified the above action of the University.

Agenda 21.18 : Any other matter with the permission of the Chair.

The minutes are issued with the approval of the Chairman for circulation to Hon'ble members.

(Prof. Samsher)
Registrar

No. F.DTU/Org/AC/Meeting/01(1)/10/Vol-IX/ **Dated :**

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. Prof. S. K. Garg, Pro VC, DTU
4. All Deans, DTU.
5. Prof. Surendra S. Yadav, Professor of Management, IIT, Hauz Khas, Delhi
6. Sh. S.G. Deshmukh, Professor, IIT, Hauz Khas, Delhi
7. Dr. Bhim Singh, Dean, Academics, IIT, Hauz Khas, Delhi
8. Prof. Smriti Srivastava, Head-Division of ICE, NSUT, Delhi
9. Prof. Tarun Kumar Das, Prof. of Mathematics & Registrar, University of Delhi
10. Sh. Lokesh Mehra, A-166, Ground Floor, Sarita Vihar, Delhi 110076
11. All HODs, DTU.
12. Prof. Rakesh Kumar, Civil Engg. Deptt.
13. Prof. Narendra Kumar-I, Elec. Engg. Deptt.
14. Prof. Naveen Kumar, Mech. Engg. Deptt.
15. Sh. Neeraj Kumar Bhagat, Associate Prof.,
16. Dr. M. Jayasimhadri, Assistant Prof., Applied Physics Deptt.
17. Controller of Examinations.
18. Registrar, DTU

(Prof. Samsher)
Registrar

ANNEXURE
For
Minutes

21st meeting of
Academic Council
DTU

11-10-2019

DTU Campus, Shahbad Daulatpur, Bawana Road, Delhi-110042

1. Subject code: **MSPH 201**
2. Contact Hours:
3. Examination Duration (Hrs):
4. Relative Weight:
5. Credits:
6. Semester:
7. Subject area:
8. Pre-requisite:
9. Objective:

Course title: **Atomic and Molecular Physics**
L: 3 T: 1 P: 0
Theory: 3 Practical: 0
CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
4
ODD
DCC
NIL
The aim of this course is to introduce students with the concepts of atomic and molecular physics with their applications

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	Review of solution of Schrodinger's equation for Coulomb field and Hydrogen atom, Bohr-Sommerfeld theory of Hydrogen Atom, Angular momentum & Parity, Dipole approximation, Magnetic dipole moments, Electron spin and Vector atom model, Spin orbit Interaction, Stern-Gerlach experiment, Hydrogen fine structure, identical particles & Pauli's principle , Spectroscopic Terms and selection rules, Intensities of spectral lines.	10
2.	Fine structure of Hydrogen like atoms: Spin-Orbit Interaction, Relativistic Correction, Lamb Shift. Interaction with External Fields- Zeeman Effect, Paschen-Back and Stark effects. Many-electron atoms- LS-coupling approximation, J-J coupling, Hyperfine structures, Lande Interval rule. The idea of Hartree-Fock equations. The central field approximation, Thomas Fermi-potential, Alkali Atom Spectra, Na doublet. X-ray spectra, Fine structure in X-ray Emission Spectra, Electron spin resonance (ESR), Nuclear magnetic resonance (NMR).	12
3.	Born-Oppenheimer Approximation, Rotational spectroscopy: Rigid rotor, Rotational spectra of diatomic molecules, Intensities of spectral lines, Isotope effects, Non-Rigid Rotator, Rotation levels of polyatomic molecules: spherical, symmetric, and Asymmetric top molecules. Vibrational spectroscopy: Vibration of diatomic molecules, Harmonic oscillator and Anharmonic oscillator, Vibrational-rotational couplings, Vibration of polyatomic molecules.	10
4.	Electronic spectroscopy: Electronic spectra of diatomic molecules, vibrational coarse structure, Franck-Condon Principle, Dissociation energy and dissociation products, Rotational fine structure of Electronic-Vibration transition, Production of excited state, Radiative processes. Selection rules, Frank-Condon principle, Jablanski diagram and qualitative treatment of small molecule and large molecule limit for nonradiative transitions, Raman Effect. Idea of Symmetry elements and point Groups for diatomic and polyatomic molecules.	12
	Total	42

Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	Introduction to Atomic Spectra, by Harvey Elliott White	McGraw-Hill 1934
2.	Elementary Atomic Structure by G.K. Woodgate	Mc Graw-Hill
3.	Molecular Spectra by G. Herzberg	
4.	*Fundamentals of Molecular Spectroscopy by C.N. Banwell*	
5.	*J.J.R. Lakowicz: Principles of fluorescence spectroscopy*	*Springer, 1983*
6.	*J.K. Shimoda : Introduction to Laser Physics*	

1. Subject code: **MSPH 203**
2. Contact Hours:
3. Examination Duration (Hrs):
4. Relative Weight:
5. Credits:
6. Semester:
7. Subject area:
8. Pre-requisite:
9. Objective:

Course title: **Nuclear and Particle Physics**
L: 3 T: 1 P: 0
Theory: 3 Practical: 0
CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
4
ODD
DCC
NIL
To impart knowledge of basic properties of nuclei and nuclear structure, nuclear models, nuclear reactions and applications of nuclear physics. Capability of elementary problem solving in nuclear and particle physics, and relating theoretical predictions and measurement results.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Two Nucleon Systems & Nuclear Forces:** Nuclear Mass & size determination, Mott scattering, nuclear formfactors. Angular momentum, spin, parity, iso-spin and moments of nuclei (Electric and Magnetic),Dipole and quadrupole moments of the deuteron, Central and tensor forces, Evidence for saturation property, Neutron-proton scattering, exchange character, spin dependence (ortho and para-hydrogen), charge independence and charge symmetry. S-wave effective range theory. Proton- proton scattering (qualitative idea only). Evidence for hardcore potential. Meson theory.	10
2.	**Nuclear Models & Nuclear Decays and Reactions:** Concept of Liquid drop model, Magic nuclei, nucleon separation energy, Single particle shell model (including Mean filed approach, spin orbit coupling), Physical concepts of the unified model (Collective Model), Selection rules, Fermi theory of beta decay. Curie plot. Fermi and Gamow-Teller transitions. Logeft value, Parity violation in beta-decay. Gamma decay, selection rules, Introduction to Nuclear Reactions (Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section), Concept of Direct and compound nuclear reaction, Nuclear reactors.	12
3.	**Elementary particles:** Relativistic kinematics, Classification: spin and parity determination of pions and strange particles. Gell-Mann Nishijima scheme. Properties of quarks and their classification. Elementary ideas of SU(2) and SU(3) symmetry groups and hadron classification. Introduction to the standard model. Electroweak interaction-W & Z Bosons.	10
4.	**Advanced Detectors:** Interaction of radiation with matter (qualitative idea), Basics of Solid state detectors, Scintillation and gas detectors for particle and electromagnetic radiation detection. Idea of Calorimeter, Hybrid detectors and arrays, LIGO and INO.	10
	Total	42

Suggested Books

S. No.	Name of Books/ Authors	Year of Publication/
1.	*Introducing Nuclear Physics by K. S. Krane*	Wiley, 2008
2.	*Nuclear Physics – Theory & Experiments by R.R. Roy & B.P. Nigam*	New Age International, 2005
3.	*Nuclear Physics in A Nutshell by C. A. Bertulani*	1st Ed., Princeton University Press, 2007
4.	*Concept of Nuclear Physics by B. L. Cohen*	McGraw – Hill, 2003
5.	*Nuclear Physics by S. N. Ghoshal*	First edition, S. Chand Publication
6.	*Nuclear & Particle Physics : An Introduction by B. Martin*	Wiley, 2006
7	*Introduction to Elementary Particles by D. Griffiths*	Academic Press, 2nd Ed. 2008
8.	*Physics and Engineering of Radiation Detection by Syed Naeem Ahmed*	
9.	*Radiation detection and measurement, G.F. Knoll*	

1. Subject code: **MSPH 209**
2. Contact Hours:
3. Examination Duration (Hrs):
4. Relative Weight:
5. Credits:
6. Semester:
7. Subject area:
8. Pre-requisite:
9. Objective:

Course title: **Advanced Condensed Matter Physics**
L: 3 T: 1 P: 0
Theory: 3+1 (T) Practical: 0
CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
4
ODD
DSE
Knowledge of basic solid-state physics
The aim of this course is to prepare students for undertaking somewhat advanced studies in Condensed Matter Physics. It emphasizes on, starting from magnetism to the consequences of going beyond the independent electron approximation and an exposure to the language of second quantization- the language used in condensed matter theory research. Finally, the basics of electronic structure calculation and its application to advanced material design.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Magnetism:** Mean field theory- Curie-Weiss law; Electrostatic origin of magnetic interactions, Magnetic properties of a two-electron system, Singlet-triplet (exchange) splitting in Heitler-London approximation; Spin Hamiltonian and the Heisenberg model; Crystal fields, origin of crystal fields, Exchange interaction, origin of exchange, direct exchange, indirect exchange in ionic solids and in metals, double exchange, Landau theory of ferromagnetism, Heisenberg and Ising models, Spin excitation, Magnons.	10
2.	**Second Quantization:** Second quantization for Fermions and Bosons, Review of Bloch's theorem, Metal-Insulator transition, Mott insulators, Hubbard model, spin and charge density waves, electrons in a magnetic field, Landau levels, integer quantum Hall effect.	10
3.	**Beyond the independent electron approximation:** The basic Hamiltonian in a solid: Electronic and ionic parts, Born-Oppenheimer Approximation; The Hartree equations, Connection with variational principle; Exchange: The Hartree-Fock approximation, Hartree-Fock theory of free electrons- One electron energy, Band width, DOS, Effective mass, Ground state energy, exchange energy, correlation energy (only concept).	10
4.	**Electronic Structure of Materials:** Density functional theory, Local density approximation and beyond LDA, The tight-binding method, APW method, OPW method, Pseudo-potential method, KKR method, LMTO method, The full-potential methods, Electron in disordered solids, Coherent potential approximation (KKR-CPA), Tight-binding molecular dynamics, Car-Parinello methods and its applications to clusters and amorphous semiconductors, Applications of electronic structure methods to materials design.	12
	Total	42

Reference Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	*Introduction to Solid State Physics, C. Kittel*	Wiley India Edition, 2007
2.	*Solid State Physics, Neil W. Ashcroft and N. David Mermin*	Holt, Rinehart and Winston, 1976
3.	*Principles of the Theory of Solids, J. M. Ziman*	Cambridge University Press, 1972
4.	*Solid State Physics: An Introduction to Theory and Experiment. H. Ibach and H. Luth*	Springer Verlag; reprint edition, 1993
5.	*Quantum Theory of Solids, C. Kittel*	John Wiley & Sons Inc; New edition,1985
6.	*Condensed Matter Physics, M. P. Marder*	John Wiley & Sons, 2010
7.	*Many Particle Physics by G. D. Mahan*	Springer Science & Business Media, 2000
8.	*Advanced Solid-State Physics, Phillips*	Cambridge University Press, 2012
9.	*Lecture Notes on Electron Correlation and Magnetism, Patrik Fazekas*	World Scientific, 1999
10.	*Electronic Structure: Basic Theory and Practical Methods, Richard M Martin*	Cambridge University Press; 2008.

2. Contact Hours: L : 3 T : 1 P : 0
3. Examination Duration (Hrs.) : Theory : 3 Practical : 0
4. Relative Weight : CWS : 25 PRS : 0 MTE : 25 ETE : 100 PRE : 0
5. Credits: 4
6. Semester: ODD
7. Subject Area: DSE
8. Pre-requisite: Nil
9. Objective : To familiarize the students with the guided wave characteristics of the optical fiber and waveguide.

10. Details of Course :

S. No.	Contents	Contact Hours
1.	Guided wave Optics, Guided Wave Structures, Ray analysis, Modes of planar waveguide, Physical understanding of modes. Electromagnetic mode theory for optical propagation, Modal analysis of planar step index waveguide	12
2.	Mode theory for optical fibers: step index fibers; Propagation characteristics of step index fibers, graded index fibers, Single Mode fibers and their characteristics, Fabrication of optical fibers	12
3.	Signal degradation on optical fiber due to dispersion and attenuation, Pulse dispersion in graded index optical fibers, Material dispersion, Waveguide dispersion and design considerations Optical Sources: LEDs and Laser diodes, Detectors for optical fiber communication	12
4.	Guide wave optical components, Directional coupler: coupled mode theory Integrated Optical devices: optical switches and wavelength filters, modulators, Fabrication and characterization of optical waveguides, prism-coupling technique	12
	Total	42

Suggested Books

S. No.	Name of Books/Authors	Year of Publication/ Reprint
1	A.K.Ghatak & K.Thyagarajan, "Optical Electronics",	Cambridge University Press (1989)
2	A.K.Ghatak & K.Thyagarajan, "Introduction to Fiber Optics",	Cambridge University Press (1998).
3	G. Keiser, "Optical Fiber Communications	McGraw-Hill, Inc. (2012)
4	K Okamoto, "Fundamentals of optical waveguides",	Academic Press (2006)
5	A. Yariv and P. Yeh, "Photonics",	Oxford University Press (2007)
6	T. Tamir, "Integrated optics",	Springer-Verlag
7	J.Gowar , " Optical communication systems",	Prentice Hall India

13/9/19 13/9/19 13/9/19 13/9/19

-04- -40-

1. Subject code: **MSPH 213** Course title: **Advanced Numerical Physics**
2. Contact Hours: L: 3 T: 1 P: 0
3. Examination Duration (Hrs): Theory: 3 Practical: 0
4. Relative Weight: CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
5. Credits: 4
6. Semester: ODD
7. Subject area: DSE
8. Pre-requisite: NIL
9. Objective: The aim of this course is to introduce students with the advanced numerical methods to solve the problems related to physics.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	Classification of numerical problems, some important theorems: Superposition Principle, Uniqueness Theorem, Analytical Methods: Separation of Variables, Series Expansion Method	8
2.	Finite Difference Methods: Finite Difference Schemes for parabolic, hyperbolic and elliptic PDEs, Accuracy and Stability of finite difference solutions, Application to guided structures, Yee's Algorithm, Finite Differencing for nonrectangular systems, numerical integration, Finite difference time domain method, Split step Fourier method	12
3.	Variational Methods: Rayleigh Ritz Method, Weighted Residual Method, Collocation Method, Subdomain Method, Galerkin Method , Least Squares Method, Eigen Value problems	10
4.	Finite Element Method, Solution of Laplace's Equation, Poisson's and wave equation: Finite element discretization, element governing equations, assembling of all equations and solving resulting equations, automatic mesh generation, finite element methods for exterior problems Monte Carlo Methods, Generation of random numbers and variables, evaluation of error, numerical integration, Crude + 5Monte Carlo integration	12
	Total	42

Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	Numerical Techniques in Electromagnetics by Matthew N.O. Sadiku	CRC Press (2011)
2.	Numerical Methods in Electromagnetism	Sheppard Salon and M. V. K. Chari
3.	Monte Carlo Methods for Electromagnetics	Matthew N.O. Sadiku
4.	Finite Difference Method	Allan Taflove

13/9/19 13/5 13/05/19 13/9/19 13/9/19 -05-

1. Subject code: **MSPH 215**
2. Contact Hours:
3. Examination Duration (Hrs):
4. Relative Weight:
5. Credits:
6. Semester:
7. Subject area:
8. Pre-requisite:

9. Objective:

Course title: **Plasma Physics**
L: 3 T: 1 P: 0
Theory: 3 Practical: 0
CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
4
~~EVEN~~ odd,
DSE
Basic understanding of plasma physics, study waves in plasma via different models and various plasma applications
Acquiring basic knowledge concerning: 1) plasma production and discharges, single particle motion; 2) electrostatic waves in plasma; 3) electromagnetic waves in plasma; 4) kinetic and fluid theory; 5) plasma applications.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	Introduction to plasmas, dc plasma discharge, rf plasma discharge, microwave plasma production, surface ionization (Q-Machine), laser produced plasma, plasma measurements (density and temperature), Langmuir probe. Beam-plasma system (Schematic, electron gun design and operation, plasma production). Motion of a charged particle in electric and magnetic fields, electric field drifts, external force drifts, Magnetic moment and Adiabatic invariance, motion of charged particle in the presence of static inhomogeneous magnetic field–curvature and gradient drifts.	12
2.	Electrostatic Waves in unmagnetized Plasma (Langmuir waves, Ion acoustic waves and Electromagnetic waves). Electrostatic Waves in Magnetized Plasma (upper hybrid wave, lower hybrid wave, ion-acoustic wave, ion-cyclotron wave), energy flow in an electrostatic wave.	08
3.	Electromagnetic Waves in Magnetized Plasma (whistler waves, Alfven waves), Raleigh- Taylor instabilities, Kelvin Helmholtz instabilities, Weibel instabilities, Two stream instability (linear), Magneto-hydrodynamic instabilities. Korteweg-de Vries (KDV) equation and Nonlinear Schrödinger equation. Electromagnetic wave propagation in a magnetized plasma and Conductivity of a magnetized plasma (D.C. and A.C. conductivity).	10
4.	Introduction to Kinetic theory, Vlasov plasma model, Fluid model from kinetic model, electron plasma waves and Landau damping, solution of Vlasov equation. **Plasma Nanotechnologies**: Nanoparticles and dusty plasmas, Carbon Nanotubes (CNTs), Graphene & g-CNT hybrids. FEL: FEL Physics (motion in a wiggler magnetic field), Gain estimate and efficiency in Compton and Raman regime. CFEL: Cerenkov free electron laser interaction, electron-beam excitation of a slow wave, laser driven fusion and laser driven electron acceleration, Tokamak Confinement, Introduction to ITR.	12
	Total	42

Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ reprint
1.	Introduction to Plasma Physics and Controlled Fusion, F.F. Chen, Springer (1983)	1983
2.	Principles of Plasma Physics, N.A. Krall and A.W. Trivelpiece, McGraw-Hill LTD (1986)	1986
3.	Laser Driven Fusion, Brueckner and Jorna, Rev. Modern Physics, Vol. 46(2), P.325, 1974.	1974
4.	Interaction of Electromagnetic Waves with Electron Beams and Plasmas, C.S. Liu and V.K. Tripathi, World Scientific Singapore (1994)	1994
5.	A Review of free electron lasers, C.W. Roberson and P. Sprangle, Physics of plasmas, 1(1), P. 3, Jan 1989.	1989
6.	Free Electron Lasers by T.C. Marshall, Macmillan Publishing Co., New York (1985)	1985

1. Subject code: **MSPH 217** Course title: **Characterization Techniques**
2. Contact Hours: L: 3 T: 1 P: 0
3. Examination Duration (Hrs): Theory: 3 Practical: 0
4. Relative Weight: CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
5. Credits: 4
6. Semester: ODD
7. Subject area: DSE
8. Pre-requisite: NIL
9. Objective: The aim of this course is to introduce students with the basic concepts and principles of optical and electron microscopy, X-ray diffraction, thermogravimetric analysis, surface probe techniques and various spectroscopic techniques need to characterize the materials from bulk to nano scale associated to scientific and engineering aspects.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Diffraction Methods:** Fundamental crystallography, Generation and detection of X-rays, Diffraction of X-rays, X-ray diffraction techniques, Electron diffraction. **Surface Analysis:** Atomic force microscopy (AFM), Magnetic force microscopy (MFM) scanning tunneling microscopy (STM), X-ray photoelectron spectroscopy (XRS/ESCA), Deep Level Transient Spectroscopy (DLTS).	15
2.	**Optical microscope** - Basic principles and components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarized light, Hot stage, Interference techniques), Stereomicroscopy.	9
3.	**Electron Microscopy:** Interaction of electrons with solids, Scanning electron microscopy Transmission electron microscopy and specimen preparation techniques, Scanning transmission electron microscopy, Energy dispersive spectroscopy, Wavelength dispersive spectroscopy.	9
4.	**Spectroscopy:** Atomic absorption spectroscopy, UV/Visible spectroscopy, Fourier transform, infrared spectroscopy, Raman spectroscopy. **Thermal Analysis:** Thermo gravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermo mechanical analysis and dilatometry.	9
	Total	42

Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	*Elements of X-Ray Diffraction by* B.D. Cullity, and R.S. Stock.	Prentice-Hall, (2001)
2.	*Fundamentals of Light Microscopy and Electronic Imaging by* Murphy, Douglas B,	Wiley-Liss, Inc. USA, (2001)
3.	*Materials Characterization Techniques Sam Zhang by* Li, Lin, Ashok Kumar	CRC Press, (2008)
4.	*Characterization of Materials by* Wachtman, J.B., Kalman, Z.H.,	Butterworth Heinemann, (1993)
5.	*Thermal Analysis by Wendlandt, W.W.*	John Wiley & Sons, (1986)
6.	*Advanced Techniques for Materials Characterization, by* Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S.	Materials Science Foundations (monograph series), Volumes 49 – 51, (2009)
7	*Fundamentals of molecular spectroscopy by* C. N. Banwell,	Tata McGraw
8.	Electron Microscopy and Analysis by Googhew P.J. et al	Taylor & Francis, London (2001)

1. Subject code: **MSPH 202**
2. Contact Hours:
3. Examination Duration (Hrs):
4. Relative Weight:
5. Credits:
6. Semester:
7. Subject area:
8. Pre-requisite:
9. Objective:

Course title: **Advanced Semiconductor Devices**
L: 3 T: 1 P: 0
Theory: 3 Practical: 0
CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
4
ODD
DCC
NIL
This core course is for M.Sc. (Physics) students to make them familiar with basic and advanced semiconductor devices and their practical application.

10. Detail of Course:

Basics of semiconductor devices such as Microwave Devices, Photonic Devices, Memory devices and their working. To understand the various steps involves in the fabrication of semiconductor devices.

S. No.	Contents	Contact Hours
1.	**Microwave Devices:** Klystrons amplifiers, velocity modulation, Basic principles of two cavity klystrons, Multicavity klystron amplifier and Reflex klystron oscillator, Magnetrons, principles of operation of magnetrons and Travelling wave tube (TWT). Transferred electron devices, Gun effect, Principles of operations, modes of operation, Read diode, IMPATT diode, and TRAPATT diode.	13
2.	**Photonic Devices:** Radiative transition and optical absorption, LED, Semiconductor lasers, heterostructures and quantum well devices, photodetector, Schottky barrier and p-I-n photodiode, avalanche photodiode, photomultiplier tubes, electro-optic and magneto-optic devices.	12
3.	**Memory Devices:** Volatile-static and D-RAM, CMOS and NMOS, non-volatile-NMOS, ferroelectric semiconductors, optical memories, magnetic memories, charge coupled devices (CCD). **Other Devices:** Piezoelectric, pyroelectric and magnetic devices. SAW and integrated devices.	12
4.	**Fabrication of Semiconductor Devices:** Vacuum techniques, thin film deposition techniques, diffusion of impurities, , Czochralski Process, MBE Technique, MOCVD	05
	Total	42

Suggested Books

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	Semiconductor Devices Physics & Technology by S.M. Sze	John Wiley, 1985
2.	Semiconductor Optoelectronic Devices by Pallab Bhattacharya	PHI-India, 1995
3.	Microwave Devices & Circuits by S. Y. Liao	3rd Ed., PHI-India, 2007
4.	*Microwaves by K.L. Gupta*	

1. Subject Code: **MSPH 204** Course Title: **Space and Atmospheric Science**
2. Contact Hours: L : 3 T : 1 P : 0
3. Examination Duration (Hrs.) : Theory : 3 Practical : 0
4. Relative Weight : CWS : 25 PRS : 0 MTE : 25 ETE : 100 PRE : 0
5. Credits: 4
6. Semester: EVEN
7. Subject Area: DSE
8. Pre-requisite: Basic knowledge of space and atmospheric science
9. Objective : To impart the fundamental knowledge pertaining to space and atmosphere. Measurement of meteorological parameters using various techniques. Global warming its consequences. Effect of trace gases, aerosols on climatic conditions will be discussed.

10. Details of Course :

S. No.	Contents	Contact Hours
1.	**Earth's Atmosphere:** Layers of atmosphere, variation of temperature with height in the atmosphere: Atmospheric pressure; composition of atmosphere; Energy balance of earth and atmosphere; Green House effect; Solar and terrestrial radiation; Black body radiation, laws of black body radiation-Plank's law, Stefan-Boltzmann law and Wien's displacement law.	10
2.	**Meteorological Instrumentation:**Ground based climatic station and automatic weather station for the measurement of air temperature, humidity, atmospheric pressure; wind speed, velocity and rain fall. Air borne systems for upper air observations-Rawinsonde, Radiosonde, GPS sonde-estimation of convective boundary layer height, thermos dynamical parameters and construction of T-phigram; Introduction to Space borne systems for the measurement of meteorological parameters.	12
3.	**Air pollution and its measurement techniques:** Primary gaseous pollutants (CO_2, CH4, CO and Nox)-sources and their effects on climate/human health. Secondary gaseous pollutants (Ozone and PAN)-Formation and their effect on human health. Gaseous pollutants measurement techniques-principles block diagrams and working. Description of aerosols, sources of aerosols, aerosol production mechanisms, effects of aerosols on climate and human health. Measurement techniques-Direct measurements by sampling and remote sensing measurements by Multi wavelength solar radiometer and Lidar.	10
4.	**Radar Principles and Meteorology:** Introduction to RADAR, types of Radars- Mono-static, pulsed radar, FM-CW radar; Basic principles of pulsed (Wind Profiler) radar-Antenna Basics-radar signal processing; Types of Radar Scattering theory-Wind vector calculations; Wind Profiler Applications-Aviation, Tropical Cyclone, Thunderstorm, Meteorological (Synoptic and Mesoscale) and Environmental.	10
	Total	**42**

Suggested Books

S. No.	Name of Books/Authors	Year of Publication/ Reprint
1	Hand book of the Atmospheric Science-Principles and Applications by C.N.Hewitt and Andrea V.Jackson Black	Wiley (1970)
2	Atmospheric Chemistry and Physics by John H.Seinfield and Spyros N. Pandias	Prentice Hall (1990)
3	An Introduction to dynamics Meteorology by James R. Hotton,	Wiley (1986)
4	A first course in Atmospheric Thermodynamics by Petty G.W,	Cambridge University press (1998)

1. Subject code: **MSPH 206**
2. Contact Hours:
3. Examination Duration (Hrs):
4. Relative Weight:
5. Credits:
6. Semester:
7. Subject area:
8. Pre-requisite:
9. Objective:

Course title: **Lasers and Spectroscopy**
L: 3 T: 1 P: 0
Theory: 3 Practical: 0
CWS: 25 PRS: 0 MTE: 25 ETE: 100 PRE: 0
4
EVEN
DSE
Knowledge of atomic and molecular physics.
The aim of this course is to introduce students with the advance concepts of Lasers and spectroscopy along with their applications

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	Einstein's coefficients, Stimulated Absorption, Stimulated Emission and Spontaneous Emission, Gain Coefficient. Radiative Lifetime, Nonradiative Transitions and Spontaneous Transition probabilities. Saturation of Absorption. Gain Saturation. Widths and Profiles of Spectral Lines, Homogeneous and Inhomogeneous Broadening. Natural Linewidth, Doppler Width. Collisional Broadening of Spectral Lines.	10
2.	Basic Principles of LASERS: Laser Amplification, Laser Oscillation, Optical and Electrical Pumping, Optical Resonators, Optimization of Favorable Losses in Resonators, Resonance Frequencies of Optical Resonators, Laser Modes, Rate Equations for Two-Level, Three-Level and Four-Level Lasers, Steady-State Output. CW and Transient Laser behavior, Single-Mode Operation, Mode Locking and Q-Switching.	12
3.	LASER Systems and their Applications: Types of Lasers, Solis State lasers, Gas Lasers, Dye Lasers, Semiconductor Lasers, Excimer Lasers and Applications of Lasers. Non-Linear Spectroscopy: Harmonic generation, Phase matching, Second harmonic generation, Third harmonic generation, Optical mixing, Parametric generation of light, Self-focusing of light.	10
4.	Steady-state and Time-resolved Spectroscopy, Photoexcitation dynamics, Transient Absorption, Two Photon Processes, Frequency up-conversion, Raman Spectroscopy.	10
	Total	42

Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	K.Shimoda : Introduction to Laser Physics;	(Springer-Verlag)
2.	O. Svelto: Principles of Lasers	(Plenum Press)
3.	Laud B.B: Laser and Nonlinear optics,	Wiley eastern.
4.	W Demtroder. Laser Spectroscopy A Basic Concepts and Instrumentation	(Springer Ver-lag).
5.	Thyagarajan and Ghatak: Lasers- Theory and Applications	
6.	Hollas J. M.: Laser and non-linear optics.	

1. Subject code: **MSPH 212**
2. Contact Hours:
3. Examination Duration (Hrs):
4. Relative Weight:
5. Credits:
6. Semester:
7. Subject area:
8. Pre-requisite:
9. Objective:

Course title: **Spintronics**
L: 3 T: 1 P: 0
Theory: 3+1 (T) Practical: 0
CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
4
EVEN
DSE
Knowledge of basic solid-state physics
The course on spintronics introduces the fundamental concepts on spin electronics. This course covers a deeper insight in theories and practical knowledge of Spin dependent transport. This course is designed to provide an understanding of fundamentals of spin electronics, spin relaxation, spin transport in metal and semiconductors, and advances in spin electronic technology and futuristic materials with high spin polarization.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Magnetism in metals: Pauli paramagnetism, Spontaneously spin-split bands, Landau levels, Landau diamagnetism, Magnetism of the electron gas, Excitations in the electron gas, Spin density waves, Kondo effect, The Hubbard model, History and overview of spin electronics, Classes of magnetic materials, The early history of spin, Quantum Mechanics of spin, The Bloch sphere, Spin-orbit interaction: Rashba interaction & Dresselhaus interaction, exchange interaction.	12
2.	**Spin relaxation & Spin dependent transport:** Spin relaxation mechanisms, Spin relaxation in a quantum dots, the spin Galvanic effect, Basic electron transport, Spin-dependent transport, spin dependent tunneling: Tunnel Magnetoresistance (TMR), Magnetic tunnel Junctions (MTJ), Tunnel Junctions with Half Metals.	10
3.	**Spin Polarization & Spin injection:** Spin polarization, Spin torque effects in magnetic systems, magnetization switching, Spin injection, spin accumulation, and spin current, Spin Hall effect and Inverse Spin Hall effect, Silicon based spin electronic devices: Toward a spin field effect transistor, transistor, Spin LEDs: Fundamental and applications, Spintronic devices based on Heusler alloy, Electron spin filtering, Monolithic and Hybrid Spintronics.	10
4.	**Quantum Computing with Spin:** The quantum inverter, Dissipation less NAND gate, Universal reversible gate, Quantum gates, Qubits, Superposition states, Universal quantum gates, 2-qubit spintronic universal quantum gates.	10
	Total	42

Reference Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	*S. Blundell, Magnetism in Condensed Matter, 1st edition*	Oxford University Press, 2001.
2.	*R. C. O'Handley, Modern Magnetic Materials*	John Wiley & Sons, Inc., 2000.
3.	*T. Shinjo (Ed.) Nanomagnetism and Spintronics*	1st edition, Elsevier, 2009.
4.	*E. Y. Tsymbal and I Zutic, Handbook of Spin Transport and Magnetism*	CRC Press, 2012.
5.	*Introduction to Spintronics, S. Bandhopadhyay, M. Cahay*	CRC Press, 2008.
6.	*Spintronics: From Materials to Devices, Editors: G. H Fecher, C. Felser*	Springer, 2013

1. Subject code: **MSPH 214**
2. Contact Hours:
3. Examination Duration (Hrs):
4. Relative Weight:
5. Credits:
6. Semester:
7. Subject area:
8. Pre-requisite:
9. Objective:

Course title: **Advanced Electronics**
L: 3 T: 1 P: 0
Theory: 3 Practical: 0
CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
4
EVEN
DSE
NIL
The aim of this course is to introduce students with the Advance concept of Electronics and their applications relevant to scientific and engineering aspects.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	Enhancement mode & Depletion mode MOSFETs, Drain current and Transfer Characteristics Analysis-Linear Regime, and Saturation Regime, Parameter Evaluation: Transconductance, Drain Conductance, Cut-off Frequency	9
2.	Op-Amp Circuits: Characteristics of ideal and practical op-amp; Nonlinear amplifiers using op-amps- log amplifier, anti-log amplifier, comparators; Active filters; precision rectifiers; Op-amp based self oscillator circuits- RC phase shift, Wien bridge, non-sinusoidal oscillators.	9
3.	Elements of Communication Electronics: Principles of analog modulation- linear and exponential types; comparison among different techniques; power, bandwidth and noise immunity consideration; Generation of transmitted carrier and suppressed carrier type AM signals; principles of FM and PM signal generation. Principles of detection of different types of modulated signals (TC and SC types). Modulation techniques in some practical communication systems: AM and FM radio, VSB AM and QAM technique in TV broadcasting	9
4.	Shift register counters – Ring counter, Johnson counter, Asynchronous Ripple or serial counter Asynchronous Up/Down counter - Synchronous counters – Synchronous Up/Down counters – Programmable counters-Design of Synchronous counters: state diagram- State table –State minimization –State assignment - Excitation table and Circuit implementation; Modulo–n counter,– Non-Sequential Counter Design using JK, D and T-design. Introduction to Microprocessors: 8086, Instruction Set, Addressing Modes	6
5.	Digital to analog converter: Binary Weighted Resistors, Analog to digital converter-Successive Approximation Method; Classification of memories – ROM - ROM organization - PROM – EPROM – EEPROM – EAPROM RAM – RAM organization – Write operation – Read operation, memory expansion. Static RAM Cell-Bipolar RAM cell – MOSFET RAM cell – Dynamic RAM cell	9
	Total	42

Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	*Weste, "Principles of CMOS VLSI Design (2nd edition)"*	
2.	*Dougles A. Pucknell and kamran Eshraghian, "Basic VLSI Systems and Circuits,* *Prentice Hall of India Pvt. Ltd.*	
3.	*Kennedy, "Communication Systems". Prentice Hall of India.*	
4.	*Malvino and Leach, "Digital Principles and Application"*	
5.	*S.M.Sze, "Physics of Semiconductor Devices" (2 nd edition)*	
6.	*Morris Mano, "Digital Electronics And Logic Design"*	
7	*Gayakwad, "Operational Amplifiers"*	

1. Subject code: **MSPH 216**
2. Contact Hours:
3. Examination Duration (Hrs):
4. Relative Weight:
5. Credits:
6. Semester:
7. Subject area:
8. Pre-requisite:
9. Objective:

Course title: **Advanced Functional Materials**
L: 3 T: 1 P: 0
Theory: 3 Practical: 0
CWS: 25 PRS: 0 MTE: 25 ETE:100 PRE: 0
4
EVEN
DSE
NIL
The aim of this course is to introduce students with the basic concepts and principles of advance functional material preparation with different technique and the thereby change in properties of material related to scientific and engineering aspects.

10. Detail of Course:

S. No.	Contents	Contact Hours
1.	Introduction, Concept of functional materials, Challenges in the science and technology of advanced materials, Classification of materials, bonding in materials	10
2.	Overview of the synthesis of functional materials (inorganic materials by procedures like solid state synthesis, sol-gel process, hydrothermal synthesis, etc.,)	10
3.	Characterization of materials, structural, morphological, optical, electrical, magnetic, dielectric, physical and thermal properties of materials, and other various properties of materials.	10
4.	Potential applications of selected functional materials from various areas of inorganic, organic and hybrid materials, Process and materials optimization, Optoelectronic materials and devices, Enhancement of device performance, Recent trends in Functional materials and devices and Future perspectives of advanced functional materials	12
	Total	42

Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	*Elements of X-Ray Diffraction by* B.D. Cullity, and R.S. Stock.	Prentice-Hall, (2001)
2.	*W. D. Callister, Fundamentals of Materials Science and Engineering,*	Wiley
3.	*Advanced functional materials: a perspective from theory and experiment, Edited by Biplab Sanyal,*	Eriksson
4.	*Materials Science and Engineering, by Raghavan, V.*	*Prentice Hall*
5.	*Smart Structures and Material by Brain Culshaw,*	-
6.	*Functional materials: preparation, processing and applications by A.K. Tyagi, and S. Banerjee*	Materials Science Foundations (monograph series), Volumes 49 – 51, (2009)

13/9/2019
16/5/19
13/5/19
13/05/19
13/9/19
13/9/19

2nd YEAR

PROPOSED SCHEME FOR M.Sc.(Physics) FOURTH SEMESTER

S. No.	Subject Code	Course Title	Course Type	Credit	Contact Hours/ Week			Exam Duration		Relative Weightage %			
					L	T	P	Theory	Practical	CWS	PRS	MTE	ETE
1.	MSPH 202	Semiconductor Devices	C	4	3	1	0	3	0	25	-	25	100
2.	MSPH 204	Elective-II/ Track -I	E	4	3	1	0	3	0	25	-	25	100
3.	MSXX 206	GE-2	E	4	3	1	0	3	0	25	-	25	100
4.	MSPH 208	Advanced Physics Lab -II	E	4	0	1	6	0	3	0	50	0	0
5.	MSPH 210	Dissertation-II	C	8	0	8	0	-	-	100	-	-	200
		Total		24	9	12	6						

Credits

Total	Core	Generic Electives (GE)	Department Specific Electives (DSE)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)
24	12	4	8	-	-

S.No.	Elective-I	Elective-II
1	Fibre and Integrated Optics	Space and Atmospheric Science
2	Advanced Condensed Matter Physics	Laser Spectroscopy
3	Advanced Numerical Physics	Plasma Physics
4.	Spintronics	Advanced Electronics
5.	Characterization Techniques	Advanced Functional Materials

13.09.2019

Modification proposed by external BOS members in the light of difficulty and understanding level of students!

Spintronics to be moved to Elective-II and Plasma Physics to be moved to Elective-I.

Delhi Technological University

Department of Applied Physics

Minutes of the BOS meeting held on 13th September 2019

The Board of studies meeting was held on 13th Sep. 2019 in HOD's office at 2:00 pm in the department. The following BOS members have made it convenient to attend the meeting.

	FACULTY	DESIGNATION	SIGNATURE
1.	**Prof. Rinku Sharma**	**Chairperson**	
2.	**Prof. Avinash Sharma (GGSIPU)**	**External Member**	
3.	**Prof. M.R. Shenoy (IITD)**	**External Member**	
4.	**Prof. S.C.Sharma**	**Internal Member**	
5.	**Prof. A.Srinivasa Rao**	**Internal Member**	
6.	**Dr. Vinod Singh**	**Internal Member**	
7.	**Dr. Nitin Kumar Puri**	**Internal Member**	
8.	**Dr. Yogita Kalra**	**Internal Member**	
9.	**Dr. M.S. Mehata**	**Internal Member**	
10.	**Dr. Rishu Chaujar**	**Special Invitee**	
11.	**Dr. Ajeet Kumar**	**Special Invitee**	
12.	**Dr. M. Jayasimhadri**	**Special Invitee**	
13.	**Dr. Amrish K Panwar**	**Special Invitee**	
14.	**Dr. Bharti Singh**	**Special Invitee**	

The Minutes of BOS meeting:

1. The paper setters, internal and external examiners for B.Tech (Common to all) 1st semester, B.Tech (EP) 3rd, 5th, 7th semesters (New and Old scheme), M. Tech (NST) 1st & 3rd semesters and M.Sc. (Physics) 1st & 3rd semesters have been discussed and approved.

2. The detailed syllabus for the courses in M.Sc. (Physics) for 2nd and 4th semester were discussed and approved by the members. A modification proposed by external BoS members in the light of difficulty and understanding level of students. Spintronics (MSPH 212) to be moved to Elective-II and Plasma Physics (MSPH 215) to be move to Elective-I.
3. The experiments running in B.Tech (common to all) physics lab were reviewed and new experiments were proposed.
4. The topics taught in 1st semester B.Tech (common to all) AP 101 theory syllabus were reviewed, discussed and modified.
5. Quality policy of the department was discussed and approved by the members.
6. The meeting ended with vote of thanks to the chair.

Prof. Rinku Sharma
HOD &Chairperson

Prof. Avinash Sharma (GGSIPU)
Member

Prof. M.R. Shenoy (IITD)
Member

Prof. S.C.Sharma
Member

Prof. A.Srinivasa Rao
Member

Dr. Nitin Kumar Puri
Member

Dr. Vinod Singh
Member

Dr. M. S. Mehata
Member

Dr. Yogita Kalra
Member

Dr. Rishu Chaujar
Co-ordinator (3rd SEM.)

Dr. Ajeet Kumar
Co-ordinator (5th SEM.)

Dr. M. Jayasimhadri
Co-ordinator (7th SEM. & PhD)

Dr. Amrish K Panwar
Co-ordinator (M.Sc.)

Dr. Bharti Singh
Co-ordinator (M. Tech.)

DELHI TECHNOLOGICAL UNIVERSITY

SCHEME OF EXAMINATION

for

M.Sc. (Physics) 2019-2021

The University in tune with the Post Graduate attributes devised by the UGC developed a framework for instructional structure. The Proposed version is the minimum requirement for a Master's Degree within the limitations of CBCS norms stipulated by the UGC. The CBCS provides for inbuilt flexibilities in which the students have a choice of pursuing courses of their choice in the form of electives. This not only broadens their horizons but also intends to make students well rounded in all spheres of development. Thus, CBCS is an effective process of 'Academic Reforms' to sustain the Quality Education that focuses on the learner centric education.

SALIENT FEATURES OF CBCS GUIDELINES ISSUED BY UGC

1. The main feature of the CBCS is to make postgraduate education student centric rather than system centric or teacher centric. For achieving these objectives, the CBCS strives to create a holistic syllabus. Thus, in addition to dedicated focus on a discipline through core papers in a regular curriculum, elective papers have been added which will give students the freedom to choose the allied/applied/broad areas of their discipline and also the areas of other disciplines of their interest.

2. Further in keeping with the vision of the Government, special emphasis has been given to ability enhancement and skill development of students through elective courses under these domains which every student is required to study. However, in keeping with the spirit of CBCS here also the students will have complete freedom to choose these courses from a pool suggested by the University.

3. All papers except core papers offer complete freedom to the University in designing and reviewing the syllabi and enable them to offer their own distinct flavor and maintain their unique character. These elective papers provide them with the opportunity to develop competencies of students in their areas of strength, expertise and specialization.

4. Even in the core papers under the proposed guidelines 30% flexibility is proposed in adopting the syllabus as per the template advised by the UGC. It is pertinent to point out that as per the existing education policy different institutions and universities are required to maintain 70% equivalence in the syllabi and the same is being maintained under the proposed system of CBCS.

5. The Departments / Schools must ensure the reasonable and manageable number of credits within the stipulated hours of Instruction not exceeding 30 Hours per Week and also stipulation of an exclusive 10 Hours per Week must be available for active participation of Student in MOOC's, Co and Extra-curricular Activities for achieving Student's Holistic Development.

6. The Department can have the option of 4 Core papers or 3 Core + 1 DSE or mix of two across the semesters. For example, in Semester-I there could be 4 core papers. In Semester II there could be 3 Core and 1 DSE or like. Core courses may have seminar, industrial training and projects. One among the pool of papers offered by the

Department in each semester may be treated as **Discipline Specific Elective (DSE)** across the University. Each of the Core courses and DSE shall be of 4 credits. Credits under DSE may vary (16/12/8) depending upon the number of DSE offered across the semesters. However, the combination of Core (48/52/56) and DSE (16/12/8) shall be of a minimum 64 credits.

7. The interested Students may opt for Project Work, against the Discipline Specific Elective (DSE) offered in IV Semester; however, it may carry 6 Credits for any of the General Education programs. In case of specifics of any discipline, Project work / Dissertation could constitute Core and Mandatory also carry 6 credits and an additional 2 credits of total credits.

8. Each **Generic Elective paper** **(GE)** will be of 4 Credits and Students has the choice of taking 2 GE's across the 4 semesters. Each student has to take Generic Electives from Department other than the parent Department. Core / DS Electives will not be offered as Generic Electives.

9. Additional Credits may be permitted to accrue under Mandatory Non-CGPA Credit Courses, which classified into two groups one is Compulsory Specified Courses and another is Elective Courses or Activities.

    a) Compulsory Specified Courses: These are compulsory courses will be of 2 / 4 credits each to be opted by the students of all PG Programs under **Ability Enhancement Courses** **(AEC)** (4) and **Skill Enhancement Courses** (SEC) (2/4).

        i. Ability Enhancement Courses (AEC): Communicative English is the Mandatory Course for all except for those who opts English as Language Optional and who shall need to opt for Urdu Language under AEC and will be offered in I and III Semesters amounting to a total of minimum 4 credits. Each AEC shall be of 2 credits.

        ii. Skill Enhancement Courses (SEC): Fundamentals of Information Technology (FIT) is another Mandatory course for all and those with Computers as a Core/Elective course may choose any other enlisted course under SEC in place of FIT and will be offered in II/IV -Semester. Each SEC shall be of 2 credits.

Structure of Postgraduate programs

The two-year M.Sc. programs compromise of courses divided in six distinct areas, namely: Departmental Core (DCC), Departmental Specific Elective (DSE), Ability Enhancement Courses (AEC), Skill Enhancement Courses (SEC) and Generic Electives (GE). Credits assigned to various components of the M.Sc. curriculum are given in subsequent Tables2.

Course Coding

A course is identified by a course code designated by a string of alpha-numeric characters and a course title. In a course code, first two letters of the string indicate the Academic Program & next two letters indicate the department offering the course and the last three numbers designate particular course.

Course Number

For all the courses, the first digit corresponds to the level (year) at which a course is normally offered. The last two digits denote the number of the course, which will usually be odd for courses offered in the Odd Semester and even for courses in the Even Semester.

Abbreviations and Notations

Credits: Cr

Teaching Engagements

Every course maintains a teaching schedule for which weekly contact hours are decided for delivering lectures (L), engaging tutorials (T) and/or performing practicals (P) to make learning in a course more effective. In the syllabi, the information regarding number of course credits and contact hours per week is denoted as: Credits (L – T – P); 4 (3 – 1–0) and options are tabulated below:

Credits	L	T	P
4	3	1	0
4	4	0	0
4	3	0	2
4	2	1	2
4	2	0	4
4	0	0	8

Weights for Course Evaluation

Evaluation in every course is based on the weights assigned to various components of the course curriculum. These components are designated as under:

S. No.	Course Type			Examination		Relative Weights				
	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	3	1	0	Yes	-	25	-	25	100	-
2.	4	0	0	Yes	0	25	-	25	100	-
3.	3	0	2	Yes	Yes	25	-	25	100	-
4.	2	1	2	Yes	Yes	25	-	25	100	-
5.	2	0	4	Yes	Yes	25	-	25	100	-
6.	0	0	8	-	Yes	-	50	-	-	100

CWS	**Class Work Sessional**
MTE	**Mid Term Examination**
PRE	**Practical Examination**
PRS	**PRS Practical Sessional**
ETE	**End Term Examination**

In general, the relative weights assigned to different components of the entire course are as given in subsequent tables.

1st YEAR

PROPOSED SCHEME FOR M.Sc. (Physics) FIRST SEMESTER

Teaching Scheme					Contact Hours/ Week			Exam Duration		Relative Weightage %				
S. No.	Subject Code	Course Title	Course Type	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	MSPH 101	Mathematical Physics	C	4	3	1	0	3	0	25	-	25	100	-
2.	MSPH 103	Classical Mechanics	C	4	3	1	0	3	0	25	-	25	100	-
3.	MSPH 105	Quantum Mechanics	C	4	3	1	0	3	0	25	-	25	100	-
4.	MSPH 107	Applied Optics	C	4	3	1	0	3	0	25	-	25	100	-
5.	MSPH 109	Electronics	C	4	3	1	0	3	0	25	-	25	100	-
6.	MSPH 111	Physics Lab-I	C	2	0	0	4	0	2	-	25	-	-	50
		Total		22	15	5	4							
7.	MSHU 113*	AEC (Communicative English)	E	4	3	1	0	3	0	25	-	25	100	-

**Non CGPA Mandatory Course*

Credits

Total	Core	Generic Electives (GE)	Department Specific Electives (DEC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)
22	22	-	-	4	-

1st YEAR

PROPOSED SCHEME FOR M.Sc. (Physics) SECOND SEMESTER

Teaching Scheme					Contact Hours/ Week			Exam Duration		Relative Weightage %				
S. No.	Subject Code	Course Title	Course Type	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	MSPH 102	Advanced Quantum Mechanics	C	4	3	1	0	3	0	25	-	25	100	-
2.	MSPH 104	Statistical Mechanics	C	4	3	1	0	3	0	25	-	25	100	-
3.	MSPH 106	Computational Methods	C	4	3	1	0	3	0	25	-	25	100	-
4.	MSPH 108	Electrodynamics	C	4	3	1	0	3	0	25	-	25	100	-
5.	MSPH 110	Solid State Physics	C	4	3	1	0	3	0	25	-	25	100	-
6.	MSPH 112	Physics Lab-II	C	2	0	0	4	0	2	-	25	-	-	50
		Total		22	15	5	4							
7.	MSCT 114*	SEC (IT related Course)	E	4	3	1	0	3	0	25	-	25	100	-

**Non CGPA Mandatory Course*

Credits

Total	Core	Generic Electives (GE)	Department Specific Electives (DEC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)
22	22	-	-	-	4

2nd YEAR

PROPOSED SCHEME FOR M.Sc. (Physics) THIRD SEMESTER

Teaching Scheme					Contact Hours/ Week			Exam Duration		Relative Weightage %				
S. No.	Subject Code	Course Title	Course Type	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	MSPH 201	Atomic and Molecular Physics	C	4	3	1	0	3	0	25	-	25	100	-
2.	MSPH 203	Nuclear and Particle Physics	C	4	3	1	0	3	0	25	-	25	100	-
3.	MSPH 205	Dissertation-I	C	2	0	2	0	-	2	-	-	-	-	-
4.	MSPH 207	Elective-I/ Track-1	E	4	3	1	0	3	0	25	-	25	100	-
5.	MSXX 209	GE-1	E	4	3	1	0	3	0	25	-	25	100	-
6.	MSPH 211	Advanced Physics Lab -I	E	4	0	1	6	0	3	0	50	0	0	100
		Total		22	12	7	6							

Credits

Total	Core	Generic Electives (GE)	Department Specific Electives (DSE)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)
22	10	4	8	-	-

2nd YEAR

PROPOSED SCHEME FOR M.Sc.(Physics) FOURTH SEMESTER

Teaching Scheme					Contact Hours/ Week			Exam Duration		Relative Weightage %				
S. No.	Subject Code	Course Title	Course Type	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	MSPH 202	Semiconductor Devices	C	4	3	1	0	3	0	25	-	25	100	-
2.	MSPH 204	Elective-II/ Track -I	E	4	3	1	0	3	0	25	-	25	100	-
3.	MSXX 206	GE-2	E	4	3	1	0	3	0	25	-	25	100	-
4.	MSPH 208	Advanced Physics Lab -II	E	4	0	1	6	0	3	0	50	0	0	100
5.	MSPH 210	Dissertation-II	C	8	0	8	0	-	-	-	-	-		-
		Total		24	9	12	6							

Credits

Total	Core	Generic Electives (GE)	Department Specific Electives (DSE)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)
24	12	4	8	-	-

Subject Code	Elective-I	Subject Code	Elective-II
MSPH 207	Fibre and Integrated Optics	MSPH 204	Space and Atmospheric Science
MSPH 209	Advanced Condensed Matter Physics	MSPH 206	Laser Spectroscopy
MSPH 213	Advanced Numerical Physics	MSPH 212	Plasma Physics
MSPH 215	Spintronics	MSPH 214	Advanced Electronics
MSPH 217	Characterization Techniques	MSPH 216	Advanced Functional Materials

Credits in Four Semesters

Total	Core	Generic Electives (GE)	Department Specific Electives (DSE)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)
90	66	8	16	4	4

In addition to the above scheme

Elective Courses / Activities: These are part of Co and Extra-curricular Activities and must opt for a minimum of 2 to 6 Credits in entire duration of the program.

The Identified MOOC's subjects or any other On-line Courses offered by the Recognized Accredited University enlisted by the University.

OR

The Approved Co and Extra-curricular Activities as defined by the University.

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DELHI TECHNOLOGICAL UNIVERSITY

SCHEME OF TEACHING AND EVALUTION

MASTER OF TECHNOLOGY IN GEOINFORMATICS (GEO)

The following alphanumeric coding scheme has been adopted
Core Courses XXXYMN
Elective Courses XXXYCMN
XXX abbreviates a particular M.Tech. program, Y- (5 for M.Tech. 1 st year, 6 for M.Tech. 2 nd year),
C-credit of the course (4/3/2),
MN- Subject code (Odd number for odd semester and even number for even semester courses)

Semester-I

	S.No.	Course Code (Proposed)	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group A	1	GEO501	Remote Sensing, Photogrammetry and Satellite Image Processing	Core	4	3	0	2	15	25	20	40	-	17
	2	GEO503	Introduction to Geographic Information System and Web GIS	Core	4	3	0	2	15	25	20	40	-	
Group B	3	GEO5401/5403/…	Elective 1	Elective	4	3	0	2	15	25	20	40	-	
	4	GEO5301/5303/..	Elective 2	Elective	3	3	0	0	20	-	30	50	-	
	5	GEO5201/5203/… /UEC5201/5203/..	Elective 3/University Elective I	Elective	2	0	0	10	20	-	-		80*	
										40 each for Viva and Report				

Semester-II

	S.No.	Course Code (Proposed)	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group C	1	GEO502	Principles of Optical, Thermal and Hyperspectral Remote Sensing	Core	4	3	0	2	15	25	20	40	-	17
	2	GEO504	Microwave and Lidar Remote Sensing	Core	4	3	0	2	15	25	20	40	-	
Group D	3	GEO5402/5404/…	Elective 4	Elective	4	3	0	2	15	25	20	40	-	
	4	GEO5302/5304/..	Elective 5	Elective	3	3	0	0	20	-	30	50	-	
	5	GEO5202/5204/… /UEC5202/5204/..	Elective 6/ University Elective II	Elective	2	2	0	0	20	0	30	50	-	

Semester-III

	S.No.	Course Code (Proposed)	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
	Track 1													12
	1	GEO651	Research Project	Core	12	0	0	12	0	-	0	-	100	
	Track 2													

Group E	1	GEO601	Major Project I	Core	3	0	0	6	-	40	-	-	60	
	2	GEO6401/6403/..	Elective 7	Elective	4	3	0	2	15	25	20	40	-	
	3	GEO6301/6303/..	Elective 8	Elective	3	3	0	0	20	0	30	50	-	
	4	GEO6201/6203/..	Elective 9	Elective	2	2	0	0	20	0	30	50	-	

Semester-IV

	S.No.	Course Code (Proposed)	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group F	**Track 1**													
	1	GEO652	Research Project	Core	12	0	0	12	0	-	0	-	100	12
	Track 2													
	1	GEO602	Major Project II	Core	12	0	0	12	0	40	0	-	60	

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LIST OF ELECTIVES:

	S.No.	Course Code (Proposed)	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 1	1	GEO5401	Surveying, Satellite Geodesy, GPS/GNSS	Elective	4	3	0	2	15	25	20	40	-
	2	CSE5401	Artificial Intelligence and Expert Systems.		4	3	0	2	15	25	20	40	-
	S.No.	**Course Code (Proposed)**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 2	1	GEO5301	Probability, Statistics and Information theory in Geoinformatics	Elective	3	3	0	0	20	0	30	50	-
	2	PSY5307	Applied Mathematics		3	3	0	0	20	0	30	50	-
	3	SPD5303	Wavelets in Signal Processing		3	3	0	0	20	0	30	50	-
	S.No.	**Course Code (Proposed)**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 3	1	GEO5201	Two week Survey and Mapping Camp (Local)	Elective	2	0	0	10	20	-	-	-	80* (40 each for Viva and Report)

	2	SWE5203	Probability and Statistics		2	2	0	0	20	0	30	50	-
	S.No.	**Course Code (Proposed)**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 4	1	GEO5402	Advanced Image Processing in Geoinformatics	Elective	4	3	0	2	15	25	20	40	-
	2	SWE5406	Machine Learning		4	3	0	2	15	25	20	40	-
	3	BIO5408	Image Processing in Medicine		4	3	0	2	15	25	20	40	-
	4	SWE5408	Big Data Analytics		4	3	0	2	15	25	20	40	-
	S.No.	**Course Code (Proposed)**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 5	1	GEO5302	Modelling and Analysis of Geospatial Data	Elective	3	3	0	0	20	0	30	50	-
	2	CSE5314	Business Intelligence		3	3	0	0	20	0	30	50	-
	3	SWE5306	Pattern Recognition		3	3	0	0	20	-	30	50	-
	S.No.	**Course Code (Proposed)**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 6	1	GEO5202	Research Methods and Communication Skills	Elective	2	2	0	0	20	-	30	50	-
	2	SWE5202	Research		2	2	0	0	20	-	30	50	-

			Methodology										
	S.No.	**Course Code (Proposed)**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 7	1	GEO6401	Geoinformatics in Target Detection	Elective	4	3	0	2	15	25	20	40	-
	2	GEO6403	Geoinformatics in Geotechnical Engineering and Geohazards		4	3	0	2	15	25	20	40	-
	3	GEO6405	Geoinformatics in Transportation		4	3	0	2	15	25	20	40	-
	4	GEO6407	Geoinformatics in hydrology and Glaciology		4	3	0	2	15	25	20	40	-
	S.No.	**Course Code (Proposed)**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 8	1	GEO6301	Geoinformatics in Disaster Management	Elective	3	3	0	0	20	0	30	50	-
	2	GEO6303	Geoinformatics in Health Care		3	3	0	0	20	0	30	50	-
	3	GEO6305	Geoinformatics in Geosciences		3	3	0	0	20	0	30	50	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 9	1	GEO6201	Geoinformatics in Atmosphere and Oceanic Studies	Elective	2	2	0	0	20	0	30	50	-

	2	GEO6203	Geoinformatics in Agriculture		2	2	0	0	20	0	30	50	-
	3	GEO6205	Geoinformatics Urban Planning and Infrastructure		2	2	0	0	20	0	30	50	-
	4	GEO6207	Design and Development of Sensors for Remote Sensing		2	2	0	0	20	0	30	50	-

SEMESTER -I

SEMESTER -I

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	GEO501	Remote Sensing, Photogrammetry and Satellite Image Processing	Core 1	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Introduction: History of Remote Sensing, Remote sensing components, Sources of Energy, EMS and Radiation Spectral reflectance curves, Radiation Calculation

Platforms and Sensors: Orbital movement and Earth coverage. Sun-synchronous and Geosynchronous satellites, Active and passive sensors, Sensors characteristics, Indian Remote Sensing Satellite Program, Other satellites

Aerial Photography and Photogrammetry: Introduction, Early history of aerial photography, Basic principles of photogrammetry, image parallax, ground control for aerial photography, production of maps and ortho-photos, flight planning

Visual Image Interpretation: Introduction, fundamentals of Visual image interpretation, basic equipment used, elements of visual image interpretation, methods of search, and applications of visual image interpretation.

Digital Image Processing. Introduction, image rectification and restoration, image enhancement, classification stage, training stage, hybrid classification, output stage, accuracy assessment

Remote sensing data collection: Analog image digitization, scanning mirrors, linear arrays, Indian remote sensing systems, ASTER imagery, Airborne digital cameras, digital image data formats

Digital image processing hardware and software: CPU, mode of operation and user interface, OS, compilers, Data storage, DIP Software

Image quality assessment and statistical evaluation: sampling theory, histogram, metadata, viewing pixel values, multivariate image statistics, feature space plots, geostatistical analysis, autocorrelation and interpolation

Display Alternatives and scientific visualization: black and white image display, temporary video display, fusing remotely sensed data, length measurement, perimeter, area and shape measurement, correcting slope and aspect effects

Geometric corrections: Internal and external geometric effects,types of geometric corrections, image to map rectification, mosaicking

Image Enhancement: Image reduction and magnification, spectral profiles, contrast enhancement, raster operations, spatial filtering, PCA, vegetation indices, texture transformations

List of Practicals:

1. Introduction to different types of remote sensing data products.
2. Use of spectroradiometer to collection signature of different earth objects.
3. Training of photo interpretation files.
4. Visual Analysis of a satellite data.
5. Demo on different types of remote sensing based software.
6. Initial Statistics Extraction.
7. Atmospheric Correction.
8. Geometric Correction
9. Image Enhancement
10. Image Transformation

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Chandra, A.M. and Ghosh, S.K., "Remote Sensing and Geographical Information System", Narosa.
2	Gibson, P.J., "Introductory Remote Sensing – Principles and Concepts", Routledge.
3	Gibson, P.J. and Power, C.H., "Introductory Remote Sensing – Digital Image Processing and applications", Routledge.
4	Jensen, J.R., Digital Image Processing A Remote Sensing Perspective, 4th ed., Pearson Education
5	Jensen, J.R., Remote sensing of environment: An Earth Resource Perspective, Pearson
6	Lillesand, T.M. and R.W. Kiefer, "Remote Sensing and Image Interpretation", 4th Ed., John Wiley.
7	Mather, P.M., "Computer Processing of Remotely Sensed Images", John Wiley.
8	Schowengerdt, R.A., "Remote Sensing – Models and Methods for Image Processing", Academic Press.
9	Garg P.K, "Principles and Theory of Geoinformatics", Khanna Book Publishing Co (P) Ltd
10	Tempfli et al., Principles of Remote Sensing An Introductory Text Book, ITC, the Netherlands

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	GEO503	Introduction to Geographic Information System and Web GIS	Core 2	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Introduction : Geographical concepts and Terminology, Utility of GIS.
GIS : Various GIS packages and their salient features, Essentials components of GIS, Data acquisition through scanners and digitizers.
Introduction and Descriptions : Raster and Vector data, Remote Sensing Data input in GIS, Data storage and editing, Topology and Spatial Relationships.
Data preprocessing : GPS Coordinates Georeferencing, Map Projections in GIS, Interpolation of data, Database Construction, GIS and the GPS, Data Output.
Database structure : Database management, Data manipulation and analysis.
Spatial and mathematical operations in GIS: Buffers, Overlay, Spatial analysis, statistical modeling, Statistical reporting and graphing.
Programming languages in GIS : Google Earth Engine/Python/R, Virtual GIS.
Applications : Applications of GIS to various natural resources mapping and monitoring and engineering problems.
Web GIS : Web Page Basics, Web Mapping, Geospatial Web Services, OGC-framework of open web mapping, importance of open web mapping, international open web standards as published by the Open Geospatial Consortium
Overview of Internet concepts & features: Internet protocol, Domain Name System, Internet services, www, Web servers, Web clients, Web GIS origin and Evolution
Fundamentals-principles-architecture-components-ThinVS thik Client architecture design development. Geospatial web services.
Evolution-Impact-web content-function and interfaces –Mashup design and implementation- challenges and prospects-uses and benefits-supporting technology solution and production.
Concept-uses -functions-architectures-geoportal applications-challenges and prospects. Web page design principles, HTML, XML, data formats, helper applications, Java, databases and the Web. Application of Internet services to GIS.

List of Practicals:

1. Demo on various GIS software and their salient features.
2. Scanning and digitization (on screen).
3. Registration of maps and satellite images, and digitization and editing of features.
4. Database creation and management.
5. Buffer and overlay analysis.
6. Map preparation and composition.
7. Spatial and Mathematical operations.
8. Area and query based analysis
9. Customized application in GIS.
10. Web publishing of GIS layers.
11. 3D GIS.
12. Demo on various GIS based application.

Suggested Books :

S.No.	Name of Books/Authors/Publisher
1	Burrough, P.A. and Mc Donnel, R.A., "Principles of Geographic Information System", Oxford University Press.
2	Chrisman, Nicholas R., "Exploring Geographic Information Systems", John Wiley.
3	Demers, Michael N., "Fundamentals of Geographic Information System", 2nd Ed. Wiley.
4	Ghosh, S.K. and Chandra, A.M., "Remote Sensing and GIS", Narosa Publishing House.
5	Lo, C.P. and Young, A.K.W., "Concepts and Techniques of Geographical Information System", Prentice Hall India.
6	Longley, Paul A, Goodchild, Michael F., Maguire, David J. and Rhind, David W., "Geographic Information Systems and Science", Wiley
7	Pinde Fu and Jiulin Sun,Web GIS: "Principles and Applications", ISBN:9781589482456,ESRI
8	Chang, K. –T., Introduction to Geographic Information Systems, 4th ed., Tata McGraw Hill
9	Huisman et al., Principles of GIS An Introduction, ITC, the Netherlands

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	GEO5401	Surveying, Satellite Geodesy, GPS/GNSS	Elective I	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Principles of surveying: Various maps and their scales, Symbols and colours.
Surveying measuring equipments & techniques: Distance, Height, Angles and Directions. Compass Surveying: Bearings and Azimuths
Levelling: Balancing of sights, Differential leveling, profile and cross-section leveling, Fall method, Contouring
Trigonometrical Leveling and Tacheometric surveying
Methods of control establishment: Traversing, Traverse computations and adjustments.
Modern surveying equipments: Total Station, DGPS
Concept of observation and model: The mathematical model and errors, Purpose of adjustments
Least squares adjustment techniques: Adjustment by linear and non-linear functions in the model, condition equation methods.
Introduction to geodesy & its development
Earth and its size & shape: Earth and its motions
Earth and its gravity field: anomaly, gravity potential, geoid
Earth and its atmosphere: physical properties, wave propagation through atmosphere, temporal variations, gravitational field of the atmosphere.
Introduction to GPS/GNSS: Introduction to GPS/GNSS, Satellite Navigations constellations today, GPS Errors Future of GPS.
Reference Systems and Coordinate systems: Geodetic coordinate systems, Datum transformations, Height systems, Time systems.
Satellite Signal: Structure of GPS Signal, Frequency, P Code, C/A code and data format, Generation of C/A code, Navigation data bits.
GPS Observables: Pseudo range measurements, Phase measurements, system accuracy characteristics, DOP, Data formats.
Surveying with GPS: Planning a GPS Survey, Positioning methods, Static, Fast static, RTK, Differential.
Data Processing: Ambiguity resolution, Post processing, real-time processing, Accuracy measures, software modules, GIS and GPS data integration.
Surveying with GPS: Navigation with GPS, Future of GPS: Modernization plans of navigational satellites, Hardware and software improvements.
Recent trends in surveying and mapping: e.g. UAV/Drone based survey.

List of Practicals:

1. Introduction to surveying instruments
2. Traingulation survey using Theodolite/ Compass/ Chain & Tape
3. Levelling using different surveying methods
4. Demonstration, hands-on practice and collection of data using Total Station
5. Demonstration, hands-on practice and collection of data using navigational GPS receiver. Further, download and process the data using software.
6. To determine the relative as well as absolute gravity of some stations and along a profile of 100meter at an interval of 5 meter. Find the location of the stations as well as plot the profile using GPS receivers.
7. To determine the height of a tower using a Gravimeter and verify the result with that by using GPS receiver.
8. To determine the variations of gravity with elevation. Determine the elevation of the stations using GPS receiver.
9. To determine the gravity anomaly profile in the DTU campus having absolute locations of the stations using GPS receivers.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Bomford, G., "Geodesy", Clarendon Press, Oxford.
2	Hoffmann-Wellenhoff, B., "GPS Theory & Practice", Springer.
3	Leick, A., "GPS Satellite Surveying", John Wiley.
4	Torge, W., "Geodesy : An Introduction", Walter de Gruyter, Berlin.
5	Vanicek, Peter and Krakiwsky, E.J., "Geodesy : The Concepts", Elsevier.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	GEO5301	Probability, Statistics and Information theory in Geoinformatics	Elective 2	3	3	0	0	Yes	No	20	30	50	-	00

Details of Course:

Basic Statistics: Sources of Data, The Histogram, Measures of central tendency, Mean Deviation, Standard Deviation, Correlation, Coefficient of correlation, Rank correlation.
Probability: Equally likely, mutually exclusive events, additions & multiplication theorems of probability and problems based on them. Bayesian approach
Geostatistics: Pattern Analysis, Measures of Arrangements & dispersion, Auto Correlation, Semiveriogram, Kriging.
One dimensional and Two dimensional random variables: Random variables, Probability function, Functions of a Random Variable, weighting of observations, multiple regression analysis
Distributions and Introduction to Estimation Theory: Different types of distributions, univariate, bivariate and multivariate distributions including density functions. Unbiased Estimators, Method of Moments, Maximum Likelihood Estimation, propagation of systematic and accidental errors, theory of least squares and its application to adjustment problems.
Multivariate analysis: Vector random variables, sample estimate of centroid, standard deviation, dispersion, correlation matrices and Gaussian mixture models. Statistics and sampling distributions, Type I and Type II errors, Tests based on Normal, T, Chi-square and F distributions for testing of mean, variance and proportions, Tests for Independence of attributes and Goodness of fit, Testing of hypotheses: Principal components, Sample variation by principal components, and Principal components by graphing.
Information Theory: Entropy, Relative Entropy, Mutual Information, Information Inequalities, Block to variable length coding, Kraft's inequality.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Probability and statistics for Engineering and the Sciences-Jay L. Devore, Cengage Learning.
2	Applied multivariate methods for data analysis- Dallas E Johnson et al, S. Chand.
3	Probability and Statistics for Engineer Richard Johnson- Miller & Freund, Pearson.
4	Rice, J.A. "Mathematical Statistics and Data Analysis", 3rd Edition, Cengage Learning
5	Jay L. Devore, "Probability and statistics for Engineering and the Sciences", 8th Edition, Cengage Learning
6	Thomas M. Cover, Joy A. Thomas, ``Elements of Information Theory", 2nd Edition, John Wiley & Sons
7	Robert G. Gallager, ``Information Theory and Reliable Communications", John Wiley & Sons

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	GEO5201	Two week Survey and Mapping Camp (Local)	Elective 3	2	0	0	10	No	Yes	20	0	0	0	80* (40 each for Viva and Report)

Details of Course:

Reconnaissance and establishing the control stations, GNSS observation for control points, Control network densification and topographic mapping using Total Station, Road profiling, Hand-held GNSS survey for GIS data, collection, Second Week Course Content: Use of automatic and digital levels, Electronic theodolites, total stations, control surveys using GNSS, Total station and traversing methods (adjustment and computations of coordinates), Laser Scanning for mapping, Multi-sensor surveying, Cartography and report writing, UAV & Drone based survey, Identify the lake depth using Echo sounder, Task based projects (concurrent)

Instruments and Software Required:

1. Electronic theodolite, Total station
2. Handheld GPS, Differential Global Positioning System (DGPS) with two to three receivers
3. Laser Scanner, Echo sounder
4. Unmanned Aerial Vehicle (UAV)
5. GPS and LiDAR data processing software

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Bomford, G., "Geodesy", Clarendon Press, Oxford.
2	Hoffmann-Wellenhoff, B., "GPS Theory & Practice", Springer.
3	Leick, A., "GPS Satellite Surveying", John Wiley.
4	Torge, W., "Geodesy : An Introduction", Walter de Gruyter, Berlin.
5	Vanicek, Peter and Krakiwsky, E.J., "Geodesy : The Concepts", Elsevier.

SEMESTER - II

SEMESTER - II

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	GEO502	Principles of Optical, Thermal and Hyperspectral Remote Sensing	Core 3	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Introduction to optical, thermal and hyperspectral remote sensing: Introduction to spectral characteristics of remote sensing data. Thermal sensors and their Characteristics.
History of thermal IR Sensing: Brief review of thermal remote sensing, Thermal IR properties, Thermal radiation laws, Interpretation of thermal images, Radiometric calibration of Thermal IR Scanner data, Thermal IR environmental considerations, Thermal IR Sensing Examples.
Thermal IR Sensor systems: Radiation terminology and Units, Introduction to IR target detection, IR signature characterization and signature measurement.
Thermal infrared region models: Emissivity consideration, Factors affecting analysis of thermal images, Estimation of land surface temperature from thermal images, Applications of thermal remote sensing.
Hyperspectral remote sensing: Hyperspectral sensors, data calibration, data exploitation algorithms, applications of imaging spectroscopy, history of spectral remote sensing.
Spectral properties of Materials: Geometrical description and directional emissivity, Elements of mineral spectroscopy, man made materials.
Statistical models of for spectral data: Univariate and bivariate distributions, statistical analysis of hyperspectral imaging data, Gaussian mixture models.
Linear spectral transformations: Implications of high dimensionality, Principal Component Analysis, MNF transforms, Canonical Correlation analysis (CCA), data compression.
Spectral Mixing: LMM model, Endmember determination techniques, least squares estimation, hypothesis tests for model parameters, model selection criteria, LSMA in practice.
Application of hyperspectral remote sensing: Target detection, hydrology, Lithology, mineral exploration, agricultural crop systems, environmental and resource management.

List of Practicals:

1. Familiarisation with various thermal remote sensing data products
2. Hands on experience on thermal data
3. data processing modules in an image processing software
4. Study and collection of emmissivity data pertaining to various earth surface features from different sources.
5. Visual image interpretation of thermal images.
6. Digital image interpretation of thermal images.
7. Land surface temperature estimation from thermal images
8. Collection of spectral signatures and study of hyperspectral image
9. Classification of hyperspectral data

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Richards and Jia, Remote Sensing Digital Image Analysis An Introduction, 4th ed., Springer
2	Manual of Remote Sensing, Vol. 1 to 5, American Society of Photogrammetry and Remote Sensing.
3	Schowengerdt, R.A., "Remote Sensing Models and Methods in Image Processing", Academic Press.
4	Matzler, C., "Thermal Microwave Radiation: Application for Remote Sensing", Institute of Electrical Engineers (IEE).
5	Chang, Chein, I., "Hyperspectral Data Processing", John Wiley and Sons.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	GEO504	Microwave and Lidar Remote Sensing	Core 4	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Introduction to Microwave Remote Sensing: Active and Passive Systems, Platforms and Sensors.
Passive Microwave Systems: Background, Mathematical formulation for microwave radiation and simulation, Measurement and analysis of Brightness Temperature, Applications in various fields— Oceanography and Meteorology.
Active Microwave Systems: Basic principles of Radar, Radar Equation, Resolution, Range, Phase and Angular measurements, Microwave Scattering and its measurement, Relationships between Scene and Sensor parameters, Imaging systems – RAR and SAR. SAR Imagery—their characteristics and interpretation. Applications of microwave
remote sensing.
SAR Interferometry for DEM generation: Differential SAR Interferometry for surface displacement studies. Applications in land subsidence, landslide movements, glacier movements etc. Polarimetry in Radar Remote Sensing. Basic equations. Propagation of waves and wave polarization. HH, VV, HV and VH polarization data and their applications.
Introduction to Lasers and Lidar: Difinitions - History of Lidar Development - Lidar System Components - lidar sensors single-return, multi-return, waveform, photon-counting, Characteristics of Lidar Data - interaction of laser energy with earth surface features - Lidar Systems.

List of Practicals:

1. Familiarisation with various microwave remote sensing data products
2. Hands on experience on microwave data processing modules in an image processing software
3. Study and collection of emmissivity data pertaining to various earth surface features from different sources.
4. Study implementation of brightness temperature estimation models for passive microwave remote sensing data
5. Study and implementation of backscatter estimation models for active microwave remote sensing data
6. Visual and Digital image interpretation of SAR images.
7. Use of Differential SAR Interferometry for surface displacement studies.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Ulaby, F.T., Moore, R.K., and Fung, A.K. "Microwave Remote Sensing – Active and Passive "Wesley Publishing
2	Sabins F.F., Jr."Remote Sensing Principles and Interpretation "W.H. Freeman and company
3	Iain H.woodhouse "Introduction to microwave remote sensing, 1st edition, CRC Press, ISBN-13: 978-0415271233
4	Alexay Bunkin & Konstantin Volia.K " Laser Remote Sensing of the Ocean Methods & Publications" John & Wiley & Sons, New York
5	Robert M. Haralick and Simmonett "Image processing for remote sensing".

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	GEO5402	Advanced Image Processing in Geoinformatics	Elective 4	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Preprocessing of Remote sensing data: Atmospheric correction algorithms, resampling.
Dimensionality reduction of remote sensing imagery: PCA, MNF, Information and divergence based approaches.
Processing in Spatial Domain: linear transformation, non-linear transformation, logarithmic transformation, exponential transformation, histogram manipulations, histogram thresholding, histogram stretching, histogram equalization, Enhancement in Frequency Domain; ideal low pas filter, ideal high pass filters, band pass filter, Gaussian filters, Hough transform.
Processing in Spectral Domain: Introduction to spectral characteristics of remote sensing data, algorithms to extract spectral information.
DEM generation from stereo-satellite images: Correspondence problem, Harris corner detector, SIFT, SURF, image matching, disparity map generation, spatial interpolation, CARTOSAT DEM, SRTM DEM, ASTER DEM, Parameter extraction.
Thematic information Extraction: Pattern Recognition: Supervised classification, Unsupervised classification, fuzzy classification, Object based image analysis.
Information extraction using AI: Expert systems, decision tree classification, classification based on machine learning and regression, random forest classifier, support vector machines, neural networks.
Information extraction using image spectroscopy: Panchromatic, multispectral and hyperspectral data collection, initial image quality assessment, radiometric calibration, geometric correction, mapping and matching using hyperspectral data, selected indices useful for hyperspectral data analysis.
Change Detection: Steps required to perform change detection, thematic change detection algorithms, atmospheric correction for change detection.
Remotely Sensed derived thematic map accuracy assessment: Steps to perform accuracy assessment, error matrix, sample size, sampling design, evaluation of error matrix, change detection map accuracy assessment.

List of Practicals:

1. Study of different types of remote sensing data
2. Hands on experience on images processing modules
3. Data visualization tools – study of images
4. Feature and intensity based image registration of images
5. Spatial enhancement of remote sensing images
6. Data dimensionality reduction using feature selection and feature extraction methods
7. Advanced pattern recognition algorithms for extraction of information from images
8. Derivation of biophysical parameters from multi and hyperspectral remote sensing images

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Chen, C.H., "Information Processing for Remote Sensing", World Scientific.
2	Cheng, Chein I., "Hyperspectral Imaging : Techniques for Spectral Detection and Classification", Kluwer Academic.
3	Landgrebe, D., "Signal Theory Methods in Multi-spectral Remote Sensing", John Wiley.
4	Richards, John A. and Xiuping, Jia., "Remote Sensing Digital Image Analysis : An Introduction", Springer-Verlag.
5	Varshney, P.K. and Arora, Manoj K., "Advanced Image Processing Techniques for Hyperspectral Remote Sensing Data", Springer-Verlag.
6	Faugeras, O., Three dimensional computer vision, A geometric viewpoint, MIT Press.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	GEO5302	Modelling and Analysis of Geospatial Data	Elective 5	3	3	0	0	Yes	No	20	30	50	-	00

Details of Course:

Types of Geo-spatial Data: Ratio, Categorical and Ordinal Data, Spatial and Non-spatial data, Vector and Raster Data, Primary and Secondary Data.

Multi Criterion Decision Making: Standardisation of weights, Analytical, Hierarchical Process (AHP), Spatial Decision Support System.

Coordinate Transformations: Two-Dimensional, Conformal, Affine, Projective, Coordinate Transformation, Three-Dimensional, Conformal Coordinate Transformation, Map models and Map Projection Systems.

Geo-spatial Data Structures and Database Management Systems: Data Compression Models, DBMS and Relational DBMS, File Formats for various GIS Data Types, Digital Remote Sensing Data: File Formats.

Measurements and Analysis: Sample versus Population, Graphical Representation of Geo-spatial Data, Measures of Central Tendency – Mean, Median, Mode. Mean Vector, Measures of Variation in Data - Variance Covariance and Correlation Matrices.

Error in Geo-spatial Data and Error Modeling: Error Sources, Types of Errors – Gross, Systematic and Random Errors, Precision, Accuracy and Uncertainty, Errors in Geospatial data and measurements, Propagation of Random Errors.

Principles of Least Squares: Observation Equations, Least Squares Solution of Nonlinear Systems, Least Squares Fit of Points to a Line or Curve, Concept of Adjustment of Errors, Least Squares Adjustment Using Conditional Equations and Observation Equations.

Confidence Intervals and Statistical Testing: Sampling Distributions, Confidence Interval for the Mean: *t* Statistic, Confidence Interval for a Population Variance, Confidence Interval for the Ratio of Two Population Variances, Hypothesis Testing, Uses of Statistical Testing in Geo-spatial Data Processing.

Uncertainty Modeling of Geo-spatial Data: Uncertainties in various Geo-spatial Data, Fuzzy set, Monte Carlo Simulations, Error Ellipse for Uncertainty Quantification.

List of Practicals:

1. Familiarity with different types of Geodata: Ratio, Categorical and Nominal
2. Understanding raster and vector data
3. Familiarization with various 2D and 3D coordinate transformations and Map Projection Systems.
4. Working on a DBMS software
5. Introduction to a Statistical Software for various applications, namely,
   - i) Generation of random error data
   - ii) Error modeling
   - iii) Least Squares adjustment
   - iv) Statistical Testing
   - v) Uncertainty modeling

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Bossler, J. D., "Manual of Geospatial Science and Technology", Taylor and Francis.
2	Freund, J. E., "Mathematical Statistics", Prentice Hall of India.
3	Law, A. M. and Kelton, W. D., "Simulation, Modeling and Analysis", Tata McGraw Hill.
4	Mikhail, Edward M. and Gracie, Gordon, "Analysis & Adjustment of Survey Measurements", Van Nostrand Reinhold.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	GEO5202	Research Methods and Communication	Elective 6	2	2	0	0	Yes	No	20	30	50	-	-

Details of Course:

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory, Characteristics of scientific method, Understanding the language of research, Research Process
Problem Identification & Formulation: Research Question, Measurement Issues, Hypothesis, Hypothesis Testing
Research Design: Concept and Importance in Research, Features of a good research design, Descriptive Research Designs, Experimental Design, Concept of Independent & Dependent variables.
Qualitative and Quantitative Research: Qualitative research, Quantitative research, Concept of measurement, causality, generalization, replication. Merging the two approaches.
Measurement: Concept of measurement, Problems in measurement in research, Levels of measurement.
Sampling: Concepts of Statistical Population, Sample, Probability Sample, Determining size of the sample.
Data Analysis: Data Preparation, Bivariate analysis.

Interpretation of Data and Paper Writing: Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Intellectual property rights (IPR), Industrial design geographical indication, Ethical issues related to publishing, Plagiarism and Self-Plagiarism.
Use of Encyclopedias: Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.

Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Donald Cooper & Pamela Schindler, '' Business Research Methods'', TMGH, 9th edition
2	Alan Bryman & Emma Bell, '' Business Research Methods'', Oxford University Press.
3	C.R.Kothari, '' Research Methodology ''.

SEMESTER - III

SEMESTER – III

Track-I															
Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO651	Research Project	Core	12	0	0	12	No	Yes	0	0	100	-	0

Track-II														
Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO601	Major Project I	Core	3	3	0	0	Yes	No	20	30	50	-	-

Details of Course:

Seminar – Literature Review and Main project topic finalization

SEMESTER – III (Track-II)

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6401	Geoinformatics in Target Detection	Elective 7	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Introduction: Targets, target detection problem, types of resolutions and spatial resolutions necessary for analysis, target detection process, selection of suitable targets, properties of target, Applications of Geoinformatics in Target detection.
Datasets for target detection: Optical data, thermal data, LIDAR data, SAR data, Sources of data, Challenges in data acquisition, limitations and advantages of each dataset.
Target Detection: Target detection in Photos and Single Images/ PAN/ Multispectral Images / Optical Images, Target detection in IR images.
Target detection in Hyperspectral Images: Spectral properties of materials, statistical models for spectral data, Linear spectral transformations, Dimensionality reduction techniques, signal detection theory, hyperspectral data exploitation
Target detection algorithms: extraction targets and accuracy assessment, machine learning algorithms, unsupervised algorithms, Anomaly detection, Independent Component Analysis, Deep learning methods, thresholding, performance evaluation parameters.
Sub-pixel target detection and enhancement: Linear mixture model, end-member determination techniques, least square computation, Spectral mixture analysis. Super resolution techniques for target enhancement, Camouflaging and Camouflage breaking, Subsurface target detection using microwave data, Target detection using Lidar data, Lidar Target Detection Algorithms.
Alternative Strategies For Target detection: Assess and exploit impact of various parameters in target detection, identification of most suitable spectral wavelengths for target detection, exploitation of spectral indices, shadowed target detection and identification using decision level fusion of Hyperspectral data with LiDAR data, Camouflaged targets detection, Occluded targets using shape based contour methods on LiDAR data, Change detection strategies.

List of Practicals:

1. Image Enhancement
2. Perform Image Rectification
3. Perform Image registration
4. Perform Radiometric correction
5. Perform Geometric correction
6. Perform Histogram Stretching and Spatial Filters
7. Perform Contrast stretching, images of different spatial resolutions, and true and false color images (composites)
8. Perform Dimensionality reduction: Principal Components Analysis on satellite data
9. Perform formatting Imagery: Creating Image Mosaics
10. Explore Spectral Libraries and Hyperspectral Processing Tools (Envi/Erdas)
11. Perform Color Transforms and Data Fusion Techniques using different data sets
12. Perform Radar Image and Edge Enhancement: Texture analysis using synthetic aperture radar (SAR)
13. Perform Detection in multispectral images
14. Detection in IR images
15. Perform Detection in hyperspectral images (SAM, MF, ACE etc)
16. Detection in microwave data
17. Perform Detection in LIDAR data ((ENVI IDL or terra solid) (Lidar Point cloud classification and target's feature extraction)
18. Perform Object-Based Image Analysis
19. Perform Image Operations and Data Fusion
20. Perform Lidar and hyperspectral data fusion for detection of shadowed targets, camouflaged targets.
21. Accuracy Assessment

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	DimitrisManolakis, "Hyperspectral Imaging Remote Sensing: Physics, Sensors, and Algorithms", Cambridge University Press
2	Manolakis, D. and Shaw, G., "Detection algorithms for hyperspectral imaging applications". *IEEE signal processing magazine*, *19*(1), pp.29-43.
3.	Shaw, G. and Manolakis, D., "Signal processing for hyperspectral image exploitation". IEEE Signal processing magazine, 19(1), pp.12-16.
4	Tiwari, K.C., Arora, M.K., Singh, D.P. and Yadav, D.S., "Military target detection using spectrally modeled algorithms and independent component analysis". Optical Engineering, 52(2), p.026402.
5	Bioucas-Dias, J.M., Plaza, A., Camps-Valls, G., Scheunders, P., Nasrabadi, N. and Chanussot, J.,. "Hyperspectral remote sensing data analysis and future challenges". IEEE Geoscience and remote sensing magazine, 1(2), pp.6-36
6	Tiwari, K.C., Arora, M.K. and Singh, D., "An assessment of independent component analysis for detection of military targets from hyperspectral images". International Journal of Applied Earth Observation and Geoinformation, 13(5), pp.730-740.
7	Arora, M.K. and Tiwari, K.C., "Subpixel target enhancement in hyperspectral images". Defence science journal, 63(1), pp.63-68.
8	Weng, Q.,. "Remote sensing of impervious surfaces in the urban areas: Requirements, methods, and trends". Remote Sensing of Environment, 117, pp.34-49.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6403	Geoinformatics in Geotechnical Engineering and Geohazards	Elective 7	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Elements of image interpretation: photographic and applications in geotechnical engineering. Identification of bridges, dams, tunnels from digital maps, land form identification and land cover usage with reference to geotechnical engineering.
Possible disasters and mitigation approaches: Geoinformatics based site selection for river valley projects, surface water harvesting structures: check dam, Nala bunds, subsurface dykes etc.
Mapping of Geological Hazards: Landslide, Earthquake, Mining hazards (subsidence, flooding etc.), Volcanic hazards.
Geoinformatics applications in Hydro meteorological Hazards: Flash floods, River floods, Dam burst, Cloud burst, Cyclones, Coastal hazards and Drought. Case studies in India and neighboring countries

List of Practicals:

1. Downloading the microwave and optical data for the study
2. Geotechnical investigation of soil in disaster prone areas
3. Establishment of permananent control points in Landslide prone zones in India
4. Mapping of surface deformation in landslide prone areas
5. Mapping of earthquake prone zones in India
6. Mapping of Landslide prone areas in India
7. Mapping of flood prone areas in India
8. Mapping and monitoring of Glacial Lake Outburst Flood (GLOF) in Indian Himalaya
9. Mapping of cyclone prone zones in India
10. Mapping and monitoring of coastal zone areas

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Chu, J., Wardani, P.R., Iizuka, A., "Geotechnical Predictions and Practice in Dealing with Geohazards (Geotechnical, Geological and Earthquake Engineering)", Springer
2	Goudin, C, and White, D., "Physical Modelling in Geotechnics", CRC Press
3.	Issu, K., "Geoscience, GIS, GPS, and Remote Sensing", CRC Press

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRI
III	GEO6405	Geoinformatics in Transportation	Elective 7	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

GIS – Data Models: Data Domains and Data Modelling in GIS – T; Data Modelling Techniques; Data Modeling and Design Issues; Graph Theory and Network Analysis; Network representation of a Transportation System; Linear referencing methods and systems; Transportation Data Models for ITS and related Applications.

Transportation Data Sources and Integration: Basic Mapping Concepts; Transportation Data Capture and Data Products; Transportation Data Integration; Spatial Data Quality; Spatial and Network aggregation

Shortest Paths and Routing: Fundamental Network Properties; Fundamental Properties of Algorithms; Shortest Path Algorithms; Routing Vehicles with in Networks

Network Flows and Facility Location: Flow through Uncongested Networks; Flow through Congested Network; Facility location within Networks; Spatial Aggregation in Network Routing and location problems

GIS based Spatial Analysis and Modeling: GIS and spatial Analysis; Urban sprawl; GIS Analytical functions; Coupling Transportation Analysis and Modelling with GIS; Customising GIS; Supporting Advanced Transportation Analysis in GIS.

Transportation Planning: Transportation Analysis Zone Design; Travel demand Analysis; Landuse – Transportation Modelling; Route Planning; Decision support for Transportation Planning.

Intelligent Transportation Systems: ITS Applications; ITS Architectures and Geographic Information; Integrating GIS and ITS.

Transportation, Environment and Hazards: Mapping sensitive Environmental features; GIS and Transportation related Air Quality; Accidents and Safety Analysis; Transportation of hazardous Materials.

List of Practicals:

1. Network analysis for transportation
2. Shortest path analysis for transportation
3. Geotagging of various metro stations in Delhi/ NCR.
4. Routing vehicles within networks
5. Identifying jam related areas
6. Mapping of accident prone areas and safety anaylsis.
7. Land use transportation modelling
8. Mapping sensitive environmental features affected by transportation
9. Road condition analysis for transportation
10. Planning a Green corridor

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Miller HJ and Shaw SL, Geographic Information Systems for Transportation: Principles and Applications, Oxford University Press
2	Implementation of GIS in State DOTs, NCHRP Report No:180.
3.	Simlowitz HJ. GIS Support Transportation System Planning. International GIS Sources Book.
4	Scholton HJ and Stillwell JCH, Geographical Information Systems for Urban and Regional Planning, Kluwer Acedemic Publishers
5	Hill JC, GIS in Transportation, Transportation Research Part C

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6407	Geoinformatics in hydrology and Glaciology	Elective 7	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Fundamentals of Hydrology: Hydrological cycle – estimation of various components of hydrological cycle – clouds – rainfall – runoff – evaporation – transpiration – evapotranspiration – interception – depression storage – spectral properties of water – case studies.
Drainage Basin Assessment: Watershed divide – stream networks – Delineation and codification of watersheds – basin morphometric analysis – linear, aerial, relief aspects – Rainfall - runoff modeling – urban hydrology – flood forecasting, risk mapping, damage assessment - soil moisture area – drought forecasting and damage assessment – mitigation - Mapping of snow covered area – snow melt runoff - case studies.
Irrigation and Water Quality: Project investigation – implementation - maintenance stage - location of storage / diversion works – canal alignment – depth - area capacity curve generation - water quality parameters – physical, chemical, biological properties - water quality mapping and monitoring – correlation model for pollution detection and suspended sediment concentration– case studies.
Ground Water: Ground water prospects – surface water indicators – vegetation, geology, soil – aquifer parameters – well hydraulics – estimation of ground water potential – hydrologic budgeting – mathematical models – ground water modeling – sea water intrusion – modeling.
Watershed Management: Mapping and monitoring the catchment and command area – conjunctive use of surface and ground water – artificial recharge of groundwater – water harvesting structures – erosivity and erodability - Universal Soil Loss Equation – sediment yield – modeling of reservoir siltation – prioritization of watershed – modeling of sustainable development – information system for Natural resource management – case studies.

List of Practicals:

1. Basin/catchment/watershed delineation Statistical and spatial analysis of precipitation data using RS-GIS techniques
2. Rainfall retrieval using satellite data Estimation of interception using remote sensing Estimation of soil moisture using remote sensing
3. Estimation of evapotranspiration (ET) using remote sensing data
4. Surface water body mapping and water quality analysis
5. Snow cover area mapping and snow melt runoff modeling
6. Derivation of unit hydrograph, S-hydrograph and synthetic unit hydrograph Estimation of surface runoff using SCS method
7. Estimation of climatic water balance components
8. Soil erosion modeling using USLE & RUSLE Soil erosion modeling using revised MMF model
9. Watershed prioritization Geospatial data base creation for watershed conservation planning using RS & GIS
10. Database creation and identifying suitable sites for WHS Site suitability for hydro power projects using RS-GIS
11. Irrigation command area mapping using multi-temporal satellite data Crop water requirement calculation
12. Performance evaluation of irrigation command area using RS & GIS
13. Mapping and monitoring of waterlogged and saline areas using RS & GIS
14. Monitoring of reservoir sedimentation Area capacity curve updation using RS & GIS
15. Drought assessment using remote sensing approach
16. Trend analysis of hydro-meteorological parameters. Glacier retreat mapping and hydrological modeling for climate change scenarios
17. Planning for inter basin water transfer using geospatial technique

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Eric C. Barrett, Clare H.Power, Satellite Remote Sensing for Hydrology and Water Management, Gordon @ Breach Science publications - New York
2	Dr. David Maidment, Dr. Dean Djokic, Hydrologic and Hydraulic Modeling Support with Geographic Information Systems, Esri Press
3	Wilfried Brutsaert, Hydrology: An Introduction Cambridge University Press
4	Andy D. Ward and Stanley W. Trimble, Environmental Hydrology, 2 nd edition, Lewis Publishers
5	U.M. Shamsi, GIS Applications for Water, Wastewater, and Storm water Systems, CRC; I st edition
6	Hoalst-Pullen, Nancy; Patterson, Mark W; Geospatial Technologies in Environmental Management, Springer.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6301	Geoinformatics in Disaster Management	Elective 8	3	3	0	0	Yes	No	20	30	50	-	-

Details of Course:

Introduction: Definition, types of disasters, importance of RS and GIS for disaster management, forecast, forewarning system, disaster preparedness with respect to different disaster, SDI to facilitate Disaster Management, GIS based DSS for disaster management, satellite surveillance for disaster mitigation

Drought: Drought types, causes, mitigation measures, delineation of drought vulnerable areas, drought monitoring, GIS based drought analysis, desertification factors, monitoring vegetative biomass;

Forest Fire: Forest Fire – causes, management using GIS, risk zonation mapping, forecasting system.

Earthquake: Causes, types, effects and mitigation measures, RS and GIS in earthquake prediction and post-quake rehabilitation, GIS for earthquake disaster management, mapping tectonic lineament

Volcanoes: RS of geothermal field, mapping lava flows, volcano hazard management

Landslides: RS and GIS for zonation, monitoring and management

Soil erosion: RS and GIS for soil erosion and sediment estimation

Flood: Flood types- flash and riverine floods, snowmelt floods, ice jams and mud flows, causes and mitigation measures, flooding potential zonation mapping, flood hazard assessment, ice cover monitoring and its role in flooding

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Kates, B.I and G.F. White, ''The Environment as Hazards'' Second Edition, THE Guilford Press New York/London
2	Singh, R.B , ''Disaster Management'', Rawat Publications.
3	Gupta, H.K , ''Disaster Management ''.
4	Singh, R.B , ''Space Technology for Disaster Mitigation in India ''.
5	Savindra Singh, ''Disaster Management in Hills''.
6	Sharma, V.K , ''Disaster Management ''.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6303	Geoinformatics in Health Care	Elective 8	3	3	0	0	Yes	No	20	30	50	-	-

Details of Course:

Health Infrastructure Mapping Studies: Disease Mapping: Spatio-temporal visualization of disease pattern and trends

Geostatistical Analysis for Health studies: Epidemiological Studies – Spatial analysis of Vector borne Diseases

Health GIS: Spatial epidemiology: RS and GIS in study of epidemics and their control- (malaria, leprosy, polio, TB, filariasis, dengue, chikengunya, cholera, AIDs, cancer),

Disease mapping: bioterrorism, infectious disease modeling, Health facility location mapping, health and disease atlas of India.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Ellen K. Cromley and Sara McLafferty, "GIS and Public Health, Second Edition"

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PR
III	GEO6305	Geoinformatics in Geosciences	Elective 8	3	3	0	0	Yes	No	20	30	50	-	-

Details of Course:

Remote Sensing in geology: an overview, Basic concept of geomorphology, earth surface process and resultant landforms, Spectral characteristics o rocks and minerals, Drainage patterns – types and its significance in geologic interpretation

Interpretation of drainage patterns through aerial photographs and satellite images: Interpretation of landforms due to folding and faulting geomorphic indices of active tectonics, Interpretation of fluvial landforms, Interpretation of glacial, coastal,eolian and volcanic landforms

Interpretation of Karst landforms: Interpretation of structural and denudational landforms – cuesta, hogback , butte, mesa etc., Interpretation o landforms related to igneous, sedimentary and metamorphic rocks, Geomorphological mapping and terrain evaluation

Lithological interpretation of igneous, sedimentary and metamorphic rocks, Structure – definition, types and structural mapping Interpretation o folds, faults, unconformities and lineaments, Tectonics- active and neotectonics in Northwest Himalaya, Tectonics landforms mapping and analysi using remote and digital terrain model

Remote Sensing in Mineral exploration: An Overview and application of Remote Sensing in Mineral Exploration – Indian Examples, Remot Sensing in Oil Exploration – Features helpful in detection of target areas for oil exploration, Engineering geological Investigation , Alignment studie – roads, tunnels, canals etc Site selection studies – Dams, bridges, highways, airstrips etc, Natural disaster mapping and management.

Cyclone: cyclone monitoring using INSAT, ERS-1, NOAA and DMSP satellites, RS and GIS in hurricane mapping and mitigation, damag assessment, warning

Tsunami: types, causes, RS and GIS for warning, damage assessment and rehabilitation

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Drury, S.A., "Image Interpretation in Geology. Allen and Unwin"
2	Gupta, R.P., "Remote Sensing Geology. Springer Verlag"
3	Jensen,J.R., "Remote Sensing of the Environment: An Earth resource Perspective". Prentice Hall
4	Ray, R.G., "Aerial Photographs in geologic Interpretations. USGS Prof, Paper 373"

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6201	Geoinformatics in Atmosphere and Oceanic Studies	Elective 9	2	2	0	0	Yes	No	20	30	50	-	-

Details of Course:

State of the atmosphere: Main constituents of dry air, Vertical thermal structure of the atmosphere; Standard atmosphere; Hydrostatic equilibrium; Weather and its phenomena – Winds, cyclones, precipitation, hydrologic cycle; Surface weather and vertical structure

Elements of radiative transfer in atmosphere: Basic quantities, Blackbody radiation – basic laws - Radiative transfer equation, Physics of Gaseous absorption, emission, Scattering, Solar radiation and surface reflection; Radiation balance

Satellite and radar meteorology: Meteorological satellite instrumentation - Operational polar orbiting and geostationary satellites, weather sensors – passive radiometry, spectroscopy and occultation; active - Radar basics, conventional, radar and satellite rainfall measurements

NEXRAD system, Image interpretation: Visible infrared and water vapor imagery, Spectral properties, inversion methods and Image processing techniques for atmosphere and ocean: calibration, validation and quality control for weather data products -

Applications of ground based and satellite remote sensing for studies of e.g. temperature, composition, aerosol and cloud properties, precipitation, as well as the properties of sea surface and sea ice: chlorophyll, sea surface temperature, carbon sequestration.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	John M Wallace and Peter V Hobbs, '' Atmospheric science – An introductory Survey'' , 2nd edn,
2	Kidder, Stanley Q., Thomas H. VonderHaar. San Diego, CA, ''Satellite meteorology: an introduction'', Academic Press.
3	Satellite meteorology: online remote sensing guide. Prepared by WW2010, Urbana Champaign: University of Illinois. Online access: http://ww2010.atmos.uiuc.edu/(Gh)/guides/rs/sat/home.rxml
4	Burrows J.P., Borell P., and Platt U., The Remote Sensing of Tropospheric Composition from Space, Springer.
5	I. S. Robinson, ''Satellite Oceanography: An Introduction for Oceanographers and Remote Sensing Scientists'', Chichester: Ellis Horwood Ltd

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6203	Geoinformatics in Agriculture	Elective 9	2	2	0	0	Yes	No	20	30	50	-	-

Details of Course:

Crops acreage and yield estimation: Spectral properties of crops in optical & TIR region, Microwave backscattering behavior of crop canopy – crops identification and crop inventory – crop acreage estimation – vegetation indicés and biophysical model – Yield modeling – crop condition assessment – command area monitoring and management – Microwave RS for crop inventory – Case studies

Soil mapping: Soil classifications – Soil survey, Types and methods – Hydrological Soil grouping - Factors influencing soil reflectance properties – Characteristics of saline & alkaline Soils –principle component analysis and orthogonal rotation transformation - Soil mapping - watershed management - Problem soil identification – land evaluation – Case studies.

Damage assessment: Detection of pest & diseases – Flood mapping and Assessments of crop loss – drought assessment – Land degradation – Soil erosion & sedimentation – Soil loss assessment – Soil conservation – Agriculture damage prediction modeling.

Forestry: Forest taxonomy – inventory of forest land – forest types and density mapping – Forest stock mapping – factors influencing degradation of forest – Delineation of degraded forest - Forest change detection and monitoring – Forest fire mapping & damage assessment — biomass estimation - carbon storage – ALTM for Forest studies – urban forestry issues.

Climatic impact of Agriculture and Forestry: Concepts of Integrated surveys– global effects and climatic changes: land degradation and desertification, extreme events, - effect on forest produces health, forest hazards, sustainable forest Management and practice - biodiversity issues – invasive biotics – mitigation and adaptation – RS & GIS for drawing out action plans – watershed approach – landuse planning for sustainable development – precision farming – Case studies.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	John G. Lyon, Jack MCcarthy, "Wetland & Environmental application of GIS"
2	Margareb Kalacska, G. Arturosanchez, " Hyper spectral RS of tropical and sub tropical forest"
3	Shunlin liang, "Advances in land RS: System, modeling invention and applications"
4	James B, ''Introduction of Remote sensing, Third edition Campbell, 3rd edition Guilford Press''
5	David H. White, S. Mark Howden, ''Climate Change: Significance for Agriculture and Forestry'', Springer

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6205	Geoinformatics Urban Planning and Infrastructure	Elective 9	2	2	0	0	Yes	No	20	30	50	-	-

Details of Course:

Fundamentals: Concepts of Urbanization and Urban Areas - concept of regions - formal and functional regions - census classification of urban areas. Concepts of Urban Planning and Infrastructure, Spatial thinking, spatial tools and need of such tools for planning physical structures and functional domains - data and information, Urban land use classification. criteria and systems

Inventory and Mapping: Digital and image records, Segmentation of Built-up areas, Inventory of resources and measurements, Deduction of sprawl, renewal and morphological changes, resolution of RS data in feature extraction and object delineation, high resolution remote sensing data in urban analysis..

Assessment of Potentials: Urban morphology – Housing typology – Population estimation from remote sensing – Infrastructure demand analysis – Land suitability analysis for Urban renewal – Plan formulation for sectoral and regional, development –

Space use surveys - Urban Heat Islands- Urban Green Spaces.

Estimation and projections - Design of Urban and regional information systems – revenue and tax collection GIS - planning facilities and amenities.

Location: Allocation and Transportation Planning, Housing development, parks and social facilities planning , Classification of traffic – Optimum route and plans / shortest path – Alignment planning – Traffic and flow management – Accident analysis – case studies.

Modeling Techniques: Urban growth modeling, Expert systems in AM/FM planning, digital terrain of the urban areas and regions, DEM and socioeconomic , Land use Transportation interaction models, Intelligent transportation systems, Risk, vulnerability models in crime, accidents and disasters - case studies

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Juliana Maantay, John Ziegler, John Pickles, GIS for the Urban Environment, Esri Press
2	Allan Brimicombe, GIS Environmental Modeling and Engineering, CRC; 1 edition. CRC Press, 2nd Edition, ISBN: 978-1439808702
3	Paul Longley, Michael Batty, Spatial Analysis: Modeling in a GIS Environment Wiley
4	Michael F. Goodchild, Louis T. Steyaert, Bradley O. Parks, Carol Johnston, David Maidment, Michael Crane, Sandi Glendinning, GIS and Environmental Modeling: Progress and Research Issues (Hardcover) by,Publisher: Wiley; 1st edition
5	Roland Fletcher, The Limits of Settlement Growth: A Theoretical Outline (New Studies in Archaeology) (First edition), Cambridge University Press
6	Said Easa, Yupo Chan, "Urban Planning and Development Applications of GIS", Amer Society of Civil Engineers, ISBN: 978-0784404614
7	Harvey J. Miller, Shih-Lung Shaw, "Geographic Information Systems for Transportation: Principles and Applications (Spatial Information Systems)", Oxford University Press, USA, ISBN: 978-0195123944
8	David J Maguire, Michael F Goodchild, Michael Batty, "GIS, Spatial Analysis, and Modeling", ESRI Press
9	Urban Remote Sensing Books – CRC Press
10	Urban Remote Sensing Books – Wiley Online Books

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6207	Design and Development of Sensors for Remote Sensing	Elective 9	2	2	0	0	Yes	No	20	30	50	-	-

Details of Course:

EM Theory: Electromagnetic Spectrum, EM plane waves , Plane wave propagation in lossless media , Wave polarization in a lossless medium, Plane-wave propagation in lossy media , Electromagnetic power density , Wave reflection and transmission at normal incidence , Wave reflection and transmission at oblique incidence Reflectivity and transmissivity ,Oblique incidence onto a lossy medium , Oblique incidence onto a two-layer composite

Sensors and Transducers: Introduction, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Synchros and Resolvers, Induction Potentiometers, Micro Electromechanical Systems

Op-amp based Instrumentation: Op-Amp Fundamentals, Basic op-amp configurations, Ideal op-amp circuit analysis, Negative feedback, Feedback in op amp circuits, Loop gain, Op amp powering, I/V and V/I converters, Current amplifiers, Difference amplifiers, Triple and dual op-amp Instrumentation amplifiers, Instrumentation applications, Transducer bridge amplifiers.

Interfacing of Sensors and Signal Conditioning: Introduction, Functions of Signal Conditioning, Change of bios and level of signals, Loading effects on Sensor's output, Potential divider, Low-Pass RC filter, High-Pass RC filter, practical issues of designing passive filters, Transfer function, First order active filters, Standard second order responses, KRC filters, Multiple feedback filters, Sensitivity, Filter approximations, Cascade design, Direct design, Switched capacitor, Switched capacitor filter

Imaging sensors: Optical imaging sensors, Thermal imaging sensors, Microwave imaging sensors

Non Imaging Sensor: Spectroradiometer, Radiometer, Spectrometer, Laser range finder/altimeter

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Electromagnetic waves and radiating systems / by Edward C. Jordan, Keith G. Balmain
2	Electronic Instrumentation by H S Kalsi, Tata McGraw-Hill Education
3	Sensors And Transducers by Patranabis D, Prentice Hall India Learning Private Limited

SEMESTER - IV

SEMESTER - IV

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
IV	GEO652	**Track 1*** Research Work	Core	12	0	0	12	No	Yes	0	0	100	-	0

Details of Course:

*Publication in category 1 or category 2 journal publication is mandatory outcome of the track1. In second year (i.e. III and IV semester) Track I option is by research work.; Candidate will be finally evaluated at the end of the semester IV out of 24 credits on the basis of his/her publication (Accepted or published in category 1 or 2 journals).
Minor project must be included as a part of electives.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
IV	GEO602	**Track 2** Project- 2	Core	12	0	0	12	No	Yes	0	0	100	-	0

Data Analytics-I

Course Code: EKTM/EIT-11 **Credits - 03**

Course Outcomes:

Upon successful completion of the course the student should be able to:

1. Identify the key areas of data analytics
2. Design and implement databases for the business scenarios
3. Assess the data sources in organizations and apply techniques to improve data quality
4. Model data visualizations for effective communication and decision making
5. Apply techniques of predictive modelling to improve resource utilization

Unit 1: Introduction to data analytics and data preparation

Overview of analytics; Languages of data Science; Introduction to Descriptive Analytics, Predictive Analytics and Prescriptive Analytics; challenges in data driven decision making. Introduction to databases; Relational Databases; Basic Structured Query Language (SQL); Advanced SQL; Reporting and Data warehousing; Online Analytical Processing, Business Intelligence, Exposure to Business Intelligence tools like Qlikview, Tableau, d3j5

Unit 2: Introduction to Data Management

Identifying sources of data; Exposure to R and R-Studio, Data Preparation and exploration – variable identification, univariate analysis, bivariate analysis, dealing with imbalanced data, missing values and outliers, data transformation; Data Manipulation; Data exploration.

Unit 3: Data visualization and story telling

Introduction to Data Visualization; Business Problem Formulation; Visualizing Time, Proportion and Space; Exploratory Data Analysis and Relationship Visualization; communicating with data.

Unit 4: Predictive Modeling and Machine learning – I

Simple Linear regression, Multiple Linear Regression, Logistic regression, Clustering, Principal Component Analysis

Data Analytics II

Course Code: EKTM/EIT-12 **Credits - 03**

Course Outcome:
Upon successful completion of the course the student should be able to:

- Examine the big data management ecosystem of organizations
- Implement multiple predictive modeling and machine learning algorithms on business datasets
- Interpret the results of different models and describe how they address a business need
- Identify and design solutions to the challenges associated with implementing data mining and ML algorithms on Big Data systems
- Demonstrate capability across all stages of an analytics project, including problem identification, solution design, implementation, and business outcome generation

Unit 1: Big data management
Introduction to Big Data, Big Data ecosystem; Exposure to Python framework, Jupyter notebook, Numpy and Pandas

Unit 2: Predictive Modeling and Machine learning-II:
Model selection and advanced regression; Decision Trees and Resampling Techniques; Ensemble Models; Boosting and Random Forest; Neural Networks, Artificial Intelligence and Deep Learning

Unit 3: Complex Techniques in Statistics and Machine Learning:

Time Series Forecasting and Support Vector Machines; Text Mining- information extraction, retrieval, clustering, text summarization, Natural Language Processing; Applications of Text Mining

Unit 4: Building and Managing Analytics-Driven Organizations:
Stages of Analytics project; Analytical Management; Business Discovery Process; Use Cases for Business Analytics; Role of Analytical Leadership

List of courses as per PhD ordinance

(i) Students having M.Sc./ M.B.A. or equivalent post-graduation degree with bachelor's degree of 2/3 years' duration

Requirement: 4 Courses of 3 credits

S. NO.	Code	Course Title	Credit
1	SM 901	Research Methodology(Compulsory)	3
2	DD 901	Design for All (DfA)	3
3	DD 9XX	Elective I	3
4	DD 9XX	Elective II	3
		Total	**12**

(ii) Students having M. Tech./ M.B.A. or equivalent post-graduation degree with bachelor's degree of 4 years' duration

Requirement: 2 Courses of 3 credits

S. NO.	Code	Course Title	Credit
1	SM 901	Research Methodology(Compulsory)	3
2	DD 901	Design for All (DfA)	3
		Total	**6**

Electives

S. No.	Elective I	Elective II
1	DD 902 Sustainable Design	DD 903 Applied Ergonomics
2	DD 904 Design Representation Techniques	DD 905 User Centric Design
3	DD 906 Medical Technology Innovation	DD 907 Service Design
4	Design Thinking for Innovations	

(DR. RAVINDRA SINGH)
(Ph.D. coordinator)

Head of the Department
Department of Design
Delhi Technological University
Shahbad Daulatpur, Bawana Road,
Delhi-110042

DEPARTMENT OF DESIGN

PhD Courses Works

Each student will be required to take course work as prescribed by DRC and approved by the D-IRD. A student having M.Sc./ M.B.A. or equivalent post graduate degree with bachelor's degree of 2/3 years' duration shall be required to complete a minimum of 4 courses of 3 credits each while the student with M.Tech./M.B.A. or equivalent post graduate degree with bachelor's degree of 4 years or more shall be required to complete a minimum of 2 courses of 3 credits each as course work.

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09/8/19

09 Aug, 2019

SM 901 Research Methodology

Credits 3 [L1 T0 S4]

Design Research- Module

Qualitative and qualitative research methodology,

Questionnaire design, validation, repeatability testing, psychophysical scales,

Direct observation and activity analysis, photography as a tool in design research etc.

Reference Books

Laurel, B. (2003). Design research: Methods and perspectives. MIT press.

Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., &Wensveen, S. (2011). Design research through practice: From the lab, field, and showroom. Elsevier.

Creswell, J. W., & Clark, V. L. P. (2007). Designing and conducting mixed methods research.

Creswell, J. W. (2013). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

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09 Aug, 20

DD 901 Design for All (DfA) Credits 4 [L1 T0 S4]

Overview of universal design- timeline of UD, definition, Objectives, and its principles Introduction of different terms associated with universal design i.e., barrier free design, inclusive design, assistive technology, design for all etc. Identification of user requirements, user inclusion, types of needs, framework to extract needs from user study, various frameworks & application of Universal Design. Identification of user requirements, user inclusion, types of needs, framework to extract needs from user study, various frameworks & application of Universal Design.

Reference books

Preiser, Wolfgang F E, Ostroff, Elaine (2011), Universal Design Handbook, McGraw Hill Professional.

Levine, Danise (2003), Universal Design New york, IDEA Publication.

Steinfeld Edward and Maisel Jordana (2012), Universal Design: Creating Inclusive environments.

Hekkert, Paul (2008), Product experience, Elsevie.

Bos Members-

09 Aug, 2015

DD 902 Sustainable Design

Credits 3 [L1 T0 S4]

Sustainable design principles. Physical, mental, spiritual, cultural, social, ethical and economic issues in designing for sustainability.

Ecological footprints, ecosystem impact.

Cradle-to cradle, Cradle to grave, Frugal Design through sustainability

Integrated DFE/Eco design, design for sustainability, eco innovation, system-wide product/service strategies,

Reference Books

Mendler, S., & Odell, W. (2000). The HOK guidebook to sustainable design. John Wiley & Sons. 4.

Williams, D. E. (2007). Sustainable design: Ecology, architecture, and planning. John Wiley & Sons.

Walker, S. (2012). Sustainable by design: Explorations in theory and practice. Routledge.

Fairs, M. (2009). Green design: creative sustainable designs for the twenty-first century. North Atlantic Books.

Bos Members- .

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DD 903 Applied ergonomics **Credits 3 [L1 T0 S4]**

Definition, origin, scope and goals of ergonomics as a field of study. Examples of applications of ergonomics in design. Types of data from human at physical, physiological, cognitive and affective levels. Data gathering and analysis techniques. Design for the cognitive user. Concept of mental workload. Cognitive perspective in control panel design, graphical user interface design and various other applications.

Reference Books

Dr. Debkumar Chakraborty (1997), Indian Anthropometric Dimensions for Ergonomic Design Practice,

J. Dul, and B. Weerdmeester (1993), Ergonomics for beginners, a quick reference guide, Taylor & Francis'

C. D. Wicknes, S. E. Gordon, and Y. Liu (1997), An Introduction to Human Factors Engineering, Longman, New York.

P.W. Jordan and W.S.Green (1999), Human Factors in Product Design: current practice and future trends, Taylor & Francis, London

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DD 904 Design Representation Techniques Credits 3 [L1 T0 S4]

Different ways in design ideas can be represented for better visualization. Development of an analytical ability to deal with complexity of imagination and visualization of object from any angle. Interaction with Light- Highlights, Shadow, reflection etc. Migration of forms and Image manipulation, Metamorphosis through form, color and structure; Exposure and demonstration of Illustration and Image making software; Digital sketching; Vector illustrations; Procedural Illustrations.

Reference books

Betty.E (2002), New Drawing on the Right Side of the Brain

Wood, P., & McDonnell, P. (1994). Scientific illustration: a guide to biological, zoological, and medical rendering techniques, design, printing, and display. John Wiley & Sons.

Buxton, B. (2010). Sketching user experiences: getting the design right and the right design: getting the design right and the right design. Morgan Kaufmann.

Powell, D. (1990). Presentation techniques. New York: Little, Brown & Company.

Tal, D. (2010). Google Sketch up for site design: a guide to modelling site plans, terrain and architecture. John Wiley & Sons.

Zeman, N. B. (2014). Essential Skills for 3D Modelling, Rendering, and Animation. CRC Press.

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DD 905 User Centric Design **Credits 3 [L1 T0 S4]**

Problem solving using a System-based approach – Using knowledge and creativity to develop Product service system (PSS) based solutions to problems. User Centric Design Process, Introduction to Universal Design and its principles.

Reference Books

Hann, M. (2013). Structure and Form in Design: Critical Ideas for Creative Practice. A&C Black.

Boden, M. A. (2012). Creativity and art: three roads to surprise.

Bentley, T. (2012). Learning beyond the classroom: Education for a changing world. Routledge.

Roozenburg, N. F., & Eekels, J. (1995). Product design: fundamentals and methods (Vol. 2). Chichester: Wiley.

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DD 906 Medical Technology Innovation — Credits 3 [L1 T0 S4]

The course gives glimpse of innovating in the space of healthcare with hands on approach to identification of unmet clinical needs, invention and implementation of such technologies and also inculcate the entrepreneurial character in the students. This also covers various design principles and tools that builds foundation for understanding real meaning of user centric design process. The innovation process begins with careful identification of clinical need and moves in a stepwise approach through inventing and planning the implementation of a marketable solution. Identify: Needs Finding, Observation and Problem Identification and Need Statement Development Treatment options, Competitive landscape, Market Analysis. Case Study. Invent: Concept Generation, Ideation and Brainstorming, Concept Screening, Concept Selection, Basics of IP. Prototyping, Business Model, Case Study. Implement: Moving forward, R&D strategies, Funding Resources, Business Plan Development, Clinical Strategy. Case Study.

Reference Books

Paul G. Yock, Biodesign: The Process of Innovating Medical Technologies, Second Edition

Peter J. Ogrodnik, Medical Device Design: Innovation from Concept to Market, First edition

Badnjevic. A, Inspection of Medical Devices for Regulatory purpose, Springer, 2018

Becker Karen M, Clinical Evaluation of Medical Devices, Humana Press.

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DD 907 Service Design Credits 3 [L1 T0 S4]

Introduction to services, digital and physical interactions. Relationships between people, technology, and Design. relationships between people, technology and design; Learning from different case studies. Small projects for intervention from the view point of Service Design

Reference Books

Robert Curedale (2013), Service Design: 250 Essential Methods

Robert Curedale (2013), Design Research Methods: 150 Ways to Inform Design.

Lucy Kimbell (2015), The Service Innovation Handbook: Action-oriented Creative Thinking Toolkit for Service Organizations.

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DD 908 Design Thinking for Innovation

Credits 3 [L1 T0 S4]

Design Thinking and System Thinking from Design perspective, Scenario Maps and Metaphors, Design of system level solutions so that design can be thought of modularly as suited for different combinations and applications. Understanding, strategizing, conceptualizing and designing for complex systems.

Reference Books

John Thackara, In the Bubble: Designing in a Complex World, The MIT Press, 2005

Bruce Hanington, Bella Martin, Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions, Rockport Publishers, 2012

Donald A. Norman, Living with Complexity, MIT Press, 2010

Jeffrey Whitten and Lonnie Bentley, Systems Analysis and Design Methods, McGraw-Hill/Irwin, 2005

Gerald M. Weinberg and Daniela Weinberg, General Principles of Systems Design, Dorset House, 1988

DD 911 Seminar

Credit 1

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