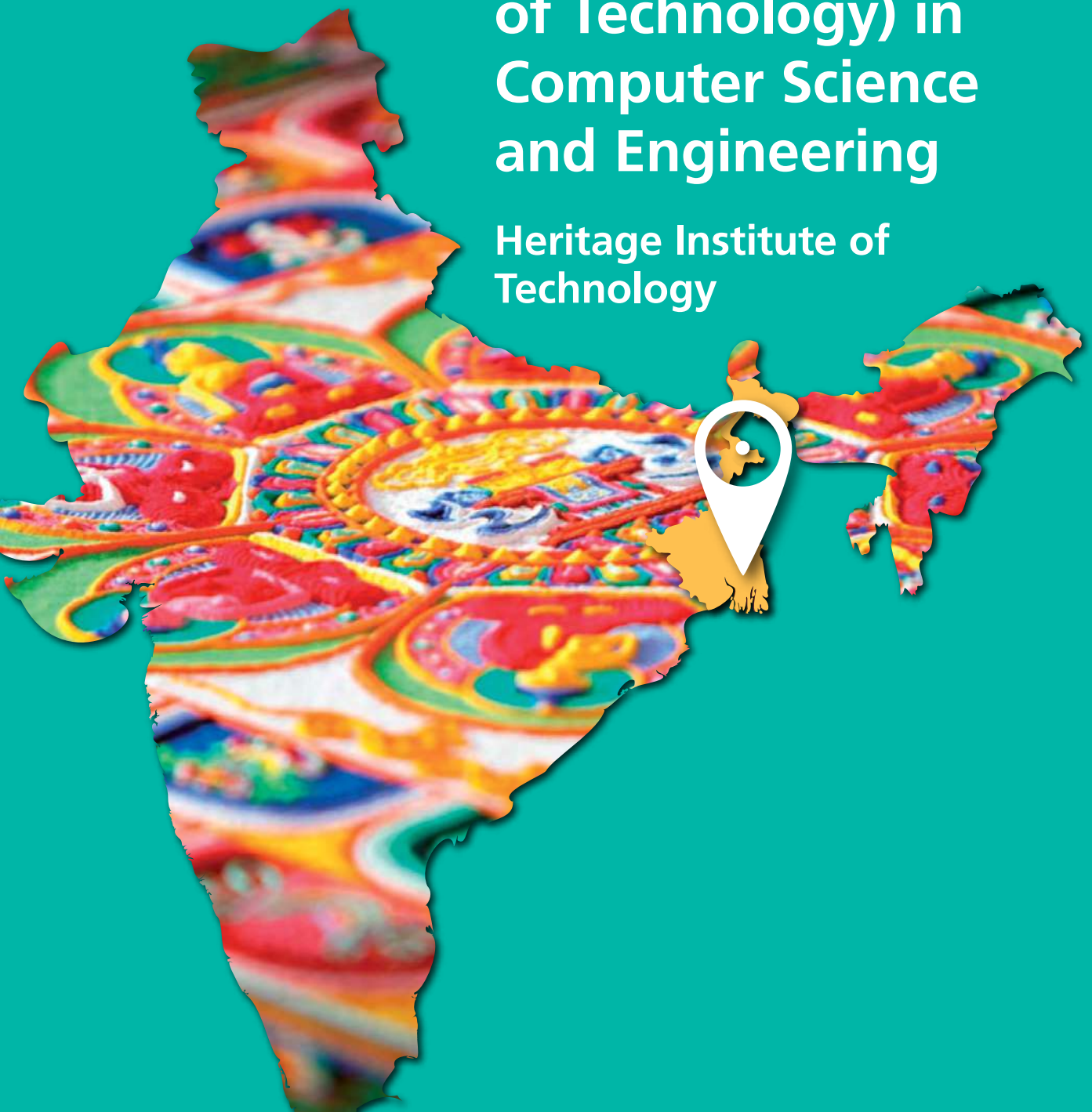
Tuning

India

Degree Programme M. Tech (Master of Technology) in Computer Science and Engineering

Heritage Institute of Technology



Degree Programme M. TECH (Master of Technology) in Computer Science and Engineering. Heritage Institute of Technology
The degree programme deals with the length, level and definition of the programme in terms of competences and learning outcomes; it also analyses the methodologies for developing the appropriate strategy of teaching, learning and assessing those competences as well as setting up the internal systems for assuring programme quality.

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Name and level of the programme

M. Tech (Master of Technology) in Computer Science and Engineering

Level: Masters

Any student completing this course is eligible for pursuing Doctoral studies in any institute or university at national or international level.

Eligibility: Bachelor of Engineering/Technology in Computer Science and Engineering/ Information Technology or Master of Science in Computer Science/Computer Applications/ Mathematics (with Computer Science Specialisation) or Master of Computer Applications (with Bachelor of Computer Applications or Bachelor of Science with Mathematics compulsory and any of the others from Statistics, Physics, Electronics or Computer Science)

2

The Social need for the programme

This program prepares the students for a career in systems or IT with a special focus on Data Analysis. It makes them ready to join the IT Industry in India, which is one of the most growing industries in this part of the world. This is a very attractive program for –

i) students who completed their Bachelors degree but could not get a suitable job with their earlier exposure

ii) those who are employed after their bachelors but still want to enhance their knowledge in order to get jobs of better quality or higher designation

iii) those who want to switch to an emerging domain with better growth opportunities

Also, many students do our course to choose a career in academics. A Masters in Computer Science and Engineering is a minimum requirement to join as a faculty member in a department related to Computer Science in any Engineering College in India. This is also a degree that anyone must have before starting their Doctoral work.

Not only does it fulfill the degree requirement, but it also trains them up for the future to do research on relevant topics and then write a doctoral thesis. So from that aspect also our program is satisfying the aspiration of the society around.

Our program has been evaluated and compared with the meta-profile defined by the Tuning India team by 6 academics from our department and on the basis of the comparison matrices prepared by them, we concluded that in only one dimension – "Teamwork, Interpersonal & Management skills", we needed to add or redesign some courses/modules to bridge the gap and so we thoroughly modified the methodology of execution of one full course to bridge that gap. For other dimensions, we had adequate representations.

3

Future fields, sectors of employment/occupation of graduates

The graduates from this department are trained adequately to join almost any domain in the IT and knowledge industry that include but not limited to the following –

i) Jobs in Data Analysis

ii) Jobs related to applications on AI (Artificial Intelligence) and Machine Learning

iii) Jobs in Mobile Computing or Mobile Applications

iv) Service Industry

v) Jobs in the domain of VLSI and EDA

vi) Jobs that require expertise in Web Services and Web-related technologies

vii) Jobs related to IoT (Internet of Things)

In addition to the above they may choose an academic career -

i) as Assistant Professors in the following departments of an engineering college – Computer Science and Engineering, Information Technology, Computer Science and Machine Learning or related domains

ii) as full-time Ph. D students with research assistantship in any national-level institutes (like Indian Institute of Technologies, Indian Institute of Sciences, Indian Statistical Institute) or universities.

iii) as a teacher of Computer Programming in any High School or Higher Secondary (10 + 2 level) school

They can also follow up an entrepreneurial career and try to found technology start-ups with funding from venture capitalists or state-funded organizations.

4

Description of the degree profile in terms of generic and subject-specific competences

Below we first state the programme-level learning outcomes (PLOs) of our Masters' course and then give the corresponding mappings of all the generic and subject-specific competences with the PLOs.

Program-level Learning Outcomes –

The graduates of the M. Tech in CSE programme at HIT can -

PLO1-solve practical problems by independently carrying out research/investigation and development work

PLO2-define the problems formally for research and implement using appropriate theoretical concepts

PLO3-produce and present a substantial technical report/document for concerned people in the appropriate knowledge domain

PLO4-communicate effectively with diverse stakeholders to provide a mutually acceptable technical solution

PLO5-lead teams as well as contribute as a member to achieve the project objectives in compliance with appropriate legal norms, quality standards, economic, and security constraints

PLO6-value the social and environmental concerns and also perform with ethical integrity in line with the profession

PLO7-develop the skill and attitude for self-learning towards comprehensive understanding of current technology and knowledge-set for continuous professional development

4.1. Generic competences and their learning outcomes

Sl. No.	Generic Competences	PLOs
1	G1: Ability to do research	PLO1, PLO2
2	G4: Ability to apply knowledge in practical situations	PLO2
3	G6: Be a life-long learner	PLO7
4	G9: Have good interpersonal skills	PLO4, PLO5
5	G14: Ability to communicate effectively	PLO4
6	G15: Ability to work as a team	PLO5
7	G21: Be adaptable to emerging trends	PLO1
8	G26: Ability to use available resources optimally and efficiently	PLO1, PLO2
9	G28: Have organizational and managerial skills	PLO5

4.2. Specific competences and their learning outcomes

Sl. No.	Subject-specific Competences	PLOs
10	S1: Applying knowledge of mathematical principles, algorithms and computer sciences to identify requirements, define, analyse and solve problems	PLO1, PLO2
11	S5: Design of ICT systems, including modeling (formal description) of their structure and processes.	PLO2, PLO3
12	S6: Deploy, install, integrate, put into service and maintain ICT systems and their elements	PLO1
13	S8: Develop ICT systems in compliance with industry specifications, standards and recommendations	PLO1
14	S11: Identify security threats and provide effective methods for information security	PLO1, PLO2
15	S12: Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and mange ICT projects.	PLO6

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Link of competences (degree profile) to the agreed meta-profile

Course Code	Course Name	MetaProfile Competence	Generic Competence	Specific Competence
CSEN 5101	Advanced Data Structure	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G4, G6, G21, G26	S1, S5, S6, S8, S11
CSEN5102	Research Methodology and IPR	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 4. Communication 5. Teamwork, Interpersonal & Management skills 6. Professional Ethics & Societal Responsibilities 7. Lifelong learning	G1, G4, G6, G9, G14, G21, G26	S1, S5, S6, S8, S11, S12
MATH5101	Advanced Discrete Mathematics and Statistical Methods	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G4, G21, G26	S1, S5, S6, S8, S11
CSEN5131	Machine Learning	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G4, G6, G21, G26	S1, S5, S6, S8, S11
CSEN5132	Advanced Wireless and Mobile Networks	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G4, G6, G21, G26	S1, S5, S6, S8, S11
CSEN5141	Data Science	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G4, G6, G21, G26	S1, S5, S6, S8, S11

Course Code	Course Name	MetaProfile Competence	Generic Competence	Specific Competence
CSEN5142	Distributed Systems	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 5. Teamwork, Interpersonal & Management skills 7. Lifelong learning	G1, G4, G6, G21, G26, G28	S1, S5, S6, S8, S11
DIMA5116	Disaster Management	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G6, G21, G26	S1, S6, S8, S11
CSEN 5201	Advanced Algorithms	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G4, G6, G21, G26	S1, S5, S6, S8, S11
CSEN 5202	Soft Computing	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G4, G6, G21, G26	S1, S5, S6, S8, S11
CSEN5234	Theory of Computation	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 5. Teamwork, Interpersonal & Management skills 7. Lifelong learning	G1, G4, G6, G21, G26, G28	S1, S5, S6, S8, S11
CSEN5235	Computational Geometry	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 5. Teamwork, Interpersonal & Management skills 7. Lifelong learning	G1, G4, G6, G21, G26, G28	S1, S5, S6, S8, S11
CSEN 5242	Graph Algorithms	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 5. Teamwork, Interpersonal & Management skills 7. Lifelong learning	G1, G4, G6, G21, G26, G28	S1, S5, S6, S8, S11
CSEN5243	Cloud Computing	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G4, G6, G21, G26	S1, S5, S6, S8, S11
CSEN5293	Term Paper and Seminar	2. Analysis, Problem Solving & Design 4. Communication 5. Teamwork, Interpersonal & Management skills	G9, G14, G15, G28	S5

Course Code	Course Name	MetaProfile Competence	Generic Competence	Specific Competence
CSEN6137	Information Retrieval	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G4, G6, G21, G26	S1, S5, S6, S8, S11
CSEN 6138	Social Network Analysis	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 7. Lifelong learning	G1, G4, G6, G21, G26	S1, S5, S6, S8, S11
MATH6121	Optimization Techniques	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance	G1, G4, G21, G26	S1, S5, S6, S8, S11
CSEN 6195	Dissertation – Phase I	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 4. Communication 5. Teamwork, Interpersonal & Management skills 7. Lifelong learning	G1, G4, G6, G9, G14, G15, G21, G26	S1, S5, S6, S8, S11
CSEN 6295	Dissertation – Phase II	1. Knowledge & Theoretical Concepts 2. Analysis, Problem Solving & Design 3. Development, Deployment & Maintenance 4. Communication 5. Teamwork, Interpersonal & Management skills 7. Lifelong learning	G1, G4, G6, G9, G14, G15, G21, G26	S1, S5, S6, S8, S11

In the next table (one for each course), derived learning outcomes from the competencies can be presented together with Assessment Activities

Assessment Strategies - For each Theory course, a student has to appear for two class tests (of duration 1 hour each) and a semester exam (3 hours duration). The semester exam is given a weightage of 70%. The rest 30% of the score (termed as internal assessment) depends on the two class tests and some quizzes and/or assignments, and the division of the weightage of the internal assessment depends upon the individual course instructors.

In the semester, a student has to answer at least 12 marks (out of 70) from each of the 4 modules.

For Labs, the focus is more on continuous evaluation, but every student has to appear for a viva-voce towards the end of the semester to check whether he/she can explain the concepts well that he/she uses to perform the experiments.

For the thesis, an external expert comes to evaluate at the end of each of the 3rd and 4th semesters. He/She evaluates the student on the quality of the thesis as well as a 30 to 40 minutes presentation. Every student works under a guide from the department who evaluates the student out of 60 and the external marks the student out of 40 and the scores are compiled together to determine the final grade.

Advanced Data Structure (CSEN 5101)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO7	The class meets for three hours every week for the whole semester. The instructor uses chalk and talk strategy, as well as uses multimedia presentations to discuss the entire course content. Once the lectures on every chapter are completed, typical problems are solved in class in an interactive manner to test the level of understanding of the students. Some home assignments are given that typically takes more time for thinking and many of them may involve programming problems.	A student has to appear for two class tests and a semester exam. The semester exam is given a weightage of 70% for deciding the final grade. The two class test typically decide the score of the rest 30%, in some years the instructor can include some assignment scores also along with the class test scores.

Research Methodology and IPR (CSEN5102)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G9, G14, G21, G26	S1, S5, S6, S8, S11, S12	PLO1, PLO2, PLO3, PLO4, PLO6, PLO7	The class meets for 2 lecture hours per week. This course involves more of theory, and faculties typically use ppts. Those students who are not already familiar with Data analysis find it very useful and it gives them a chance to grab the concepts that otherwise they would have to acquire themselves before starting to work on their thesis in the beginning of 2nd year. The content of this course is relatively new that we introduced from 2018.	They have to appear for the semester exam as usual however, for this course the internal evaluation (30%) may involve a class presentation by each of the students.

Advanced Discrete Mathematics and Statistical Methods (MATH5101)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2	This is a course conducted by the Mathematics department and it mostly involves lectures in chalk and talk mode. This is a course of high utility as knowledge in statistics is one of the basic building blocks for a Data Science career. Students who do not have an earlier exposure to a formal course on statistics get a last chance to do so and those who have, they get a chance to solve some advanced problems in this domain. Moreover, they solve a number of Graph Theoretic problems that have applications in almost all the courses they learn in the next 2 semesters.	Focus of assessment is obviously on testing the problem solving capacity of the students both in the semester as well as class-tests. Semester paper as usual in on 70 marks. The weightage of the internal portion of 30% is equally distributed on class tests (2 in number) and assignments (4 in number – one each from each module).

Machine Learning (CSEN5131)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO7	Machine learning as a subject is quite mathematically intense. So it involves a lot of involving lectures but the instructor tries to give a feel of the applications also so that the students learn how to use their knowledge in real life. A few case studies are used to teach them how to formulate a given problem in a way so that multiple machine learning tools can then be used to solve the same problem. This way the user can then have a choice for deciding which algorithm to use for a particular problem or more importantly for a particular dataset (the problem may be the same).	This course involves a lab course also along with it with a separate credit but here also the internals can involve an implementation assignment along with class tests.

Advanced Wireless and Mobile Networks (CSEN5132)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO7	As wireless and mobile networks are emerging areas of research, we give students much-needed exposure to the fundamentals as well as advanced topics of this subject. The class meets for 3 lecture hours per week. This course involves more theory, and faculties typically use PPTs. Those students who are not already familiar with W &M Networks find it very useful and it gives them an opportunity to grab the intricacies of the subject that otherwise they would have to learn themselves before starting to work on their thesis in the beginning of 2nd year, in case they choose to work on the same.	This course involves a lab course also along with it with a separate credit but here also the internals can involve an implementation assignment along with class tests. They have to sit for a semester exam of 70 marks and 2 internals of 30 marks each. The weightage of the internal portion of 30 % is equally distributed on class tests (2 in number) and assignments (instructor decides the number).

Data Science (CSEN5141)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO7	Data science is a multi-disciplinary field that uses scientific methods, processes, algorithms and systems to extract knowledge and insights from structured and unstructured data and we have designed this course keeping all of these in mind. Students get the opportunity to master this course in 3 lecture periods assigned for them per week. Faculties mainly use PPTs for lectures, class work and also verbally discuss the trending research works with students. Also, along with gaining knowledge in the basic concepts, students become able to solve real-world problems.	Same as most of the other theory courses, students have to appear for a semester as well as two internal tests. They also submit assignments, implementing programs as well as suggesting solutions for new problems where statistical analysis of Data is involved.

Distributed Systems (CSEN5142)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26, G28	S1, S5, S6, S8, S11	PLO1, PLO2, PLO7	Like all other professional electives, in this course also, students meet the instructor for three hours a week. Instructors use Powerpoint slides as a proper audio-visual medium to effectively transfer the knowledge about building blocks of distributed systems and to make students capable enough to design and implement distributed applications.	Students need to sit for two internal exams and one semester exam for this subject. Also, they need to solve some real-world problems as assignments, which help the assigned member of the faculty to evaluate their understanding of the subject.

Disaster Management (DIMA5116)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G6, G21, G26	S1, S6, S8, S11	PLO1, PLO7	This is mostly a theory course and is restricted to lecturers of 2 hours per week.	This is an audit course, which means the grade obtained in this paper does not contribute to the final Grade Point Average of the student but a student has to at least pass the subject for getting the degree.

Advanced Algorithms (CSEN5201)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO7	The stipulated number of hours given for this course is 3 hours per week as per the latest guidelines of AICTE released in 2018 for all M. tech papers in CSE. However, in our program the instructors meet the students for 4 hours per week for this course. For any course, if there is a problem with completion of syllabus for any reason (eg. Instructor had to travel for attending conference etc.), an instructor can always arrange some extra classes for some weeks. But for this subject, both the instructors and the students uniformly agree that they need those extra hours and it is always taken care of in the schedule from the beginning of the semester. Since there is an associated lab course, the instructors focus on the mathematical rigour and many of the times all the students are not found to be ready with their pre-requisites and hence the instructors are ready to explain the basics once more, which account for the informal allotment of the excess time.	The division of marks in semester exam and class tests are very similar to the other theory courses of the semester but the assignments here do not involve programming exercise, rather they are given to solve some of the harder problems from the text – Introduction to Algorithms' by Cormen, Leiserson and Rivest, which are generally avoided in the tests that have limited time.

Soft Computing (CSEN5202)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO7	Like all other professional electives, in this course also, students meet the instructor for three hours a week. Instructors use Powerpoint slides as a proper audio-visual medium to effectively transfer the knowledge about the basic tools of soft computing methods.	Students need to sit for two internal exams and one semester exam for this subject. Also, they may be given some real-world problems to solve as assignments using the tools that they have learnt in the class which help the assigned member of faculty to evaluate their understanding of the subject.

Theory of Computation (CSEN5234)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26, G28	S1, S5, S6, S8, S11	PLO1, PLO2, PLO5, PLO7	This is one of the elective courses that all the students take it uniformly. Like other electives, 3 hours per week is given for this one as per as AICTE guidelines. But the instructor thinks that one more teaching hour is needed for the completion of this course then that can be arranged after the consultation with the students. Instructor normally uses chalk and talk, as well as multimedia projector to discuss the topics. Since it is one of the basic courses as far as computer science and engineering is concerned, instructor spends more time to discuss primary topics, so that students understand it clearly.	The division of marks in semester exam and class tests are very similar to the other theory courses of the semester. Apart from that instructor gives assignments time to time to the students and the students are asked to submit those in due time. Instructor evaluates those assignments submitted by the students and some percentage of that score is added to the internal marks (out of 30).

Computational Geometry (CSEN5235)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26, G28	S1, S5, S6, S8, S11	PLO1, PLO2, PLO5, PLO7	Computational geometry is a study of algorithms in terms of geometry. So students need to have good knowledge of algorithms. Like all other professional electives, AICTE allotted 3 hours of lectures in this course too. Instructor normally uses multimedia projector to discuss the topics.	Same as most of the other theory courses, students have to appear for a semester as well as two internal tests. Since this is a bit difficult course for the students, that's why instructor may prepare some assignments on the topics discussed in the class in regular basis and asks the students to solve those and submit. It will help the instructor to get an idea how much the students understand those topics and accordingly to assess the students too.

Graph Algorithms (CSEN5242)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26, G28	S1, S5, S6, S8, S11	PLO1, PLO2, PLO5, PLO7	In Graph algorithms, complex algorithms on various types of graphs are discussed. Here also it is expected that students have the basic knowledge of algorithms. Like all other electives, the instructor meets the students for 3 lecture hours in a week for this course. Instructor normally uses multimedia projector to discuss the topics.	The division of marks in semester exam and class tests are very similar to the other theory courses of the semester. Apart from that instructor gives assignments time to time to the students and the students are asked to submit those in due time. Instructor evaluates those assignments submitted by the students and some percentage of that score is added to the internal marks (out of 30).

Cloud Computing (CSEN5243)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO7	As cloud computing is an emerging area of research, we give students much needed exposure of this subject. As per AICTE guidelines, instructor meets the students for 3 hours per week. In general Instructor uses multimedia projector to discuss the topics.	Same as most of the other theory courses, students have to appear for a semester as well as two internal tests.

Term Paper and Seminar (CSEN5293)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G9, G14, G15, G28	S5	PLO3, PLO4, PLO5	Department of computer science and engineering always encourages research activities among their students. That's the reason why this course is introduced in the M.Tech syllabus. This is where the master degree students complete the literature survey of the topic on which they will carry out their final year project. Instructor meets the students in consecutive sessions of 4 hours per week. Instructor's role here is to guide the student first how to do the literature survey on any topic. And then how to prepare a good presentation on that, as well as how to present it in an interesting way. Last but not the least instructor also advices the students how to prepare a good document that they are supposed to submit at the end.	Students will present it individually/ in a group created by the instructor. There are various metrics, like presentation skills, communication skills, technical matters covered, quality of the report submitted etc. on which instructor grades a student or a group of students.

Information Retrieval (CSEN6137)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO7	Information retrieval is a part of NLP and it is also one of the emerging areas as far as research is concerned. That's why we give students much needed exposure of this subject. As per AICTE guidelines, instructor meets the students for 3 hours per week. In general Instructor uses multimedia projector to discuss the topics.	Same as most of the other theory courses, students have to appear for a semester as well as two internal tests.

Social Network Analysis (CSEN6138)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO7	As Social network analysis is an emerging area of research, we encourage students to take this course as one of their professional electives from this bucket. As per AICTE guidelines, instructor meets the students for 3 hours per week. In general Instructor uses multimedia projector to discuss the topics.	Same as most of the other theory courses, students have to appear for a semester as well as two internal tests.

Optimization Techniques (MATH6121)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2	Students, especially M.Tech students may need to apply the knowledge of optimization techniques in their final year project work, as well as in their future research activities. As per AICTE guidelines, students meet their instructor for 3 hours per week. In general Instructor uses multimedia projector to discuss the topics.	Same as most of the other theory courses, students have to appear for a semester as well as two internal tests.

Dissertation – Phase I (CSEN6195)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G9, G14, G15, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO3, PLO4, PLO5, PLO7	Although it is written in the syllabus that AICTE allot 20 hours per week for this course, but it may be varied in reality. Students meet their project mentor in a time which was fixed after mutual discussions between them. And this meeting is taken place in regular basis, where the project related discussions are going on. Students try to give their own thoughts, whereas instructor's role is to guide their students in the right track	Assessment of this course is done in various ways. In the semester two interim viva-voce taken place by the departmental faculties. At the end of the semester students is supposed to present their work in front of an external examiner. In short the assessment weighted sum of those two interim viva score, external examiner's marks and the marks given by the respective mentor.

Dissertation – Phase II (CSEN6295)

Generic Competence	Specific Competence	Learning Outcomes	Learning and Teaching Activities	Assessment Activities
G1, G4, G6, G9, G14, G15, G21, G26	S1, S5, S6, S8, S11	PLO1, PLO2, PLO3, PLO4, PLO5, PLO7	Although it is written in the syllabus that AICTE allot 28 hours per week for this course, but it may be varied in reality. Students meet their project mentor in a time which was fixed after mutual discussions between them. And this meeting is taken place in regular basis, where the project related discussions are going on. Students try to give their own thoughts, whereas instructor's role is to guide their students in the right track	Assessment of this course is done in various ways. In the semester two interim viva-voce taken place by the departmental faculties. At the end of the semester students is supposed to present their work in front of an external examiner. In short the assessment weighted sum of those two interim viva score, external examiner's marks and the marks given by the respective mentor.

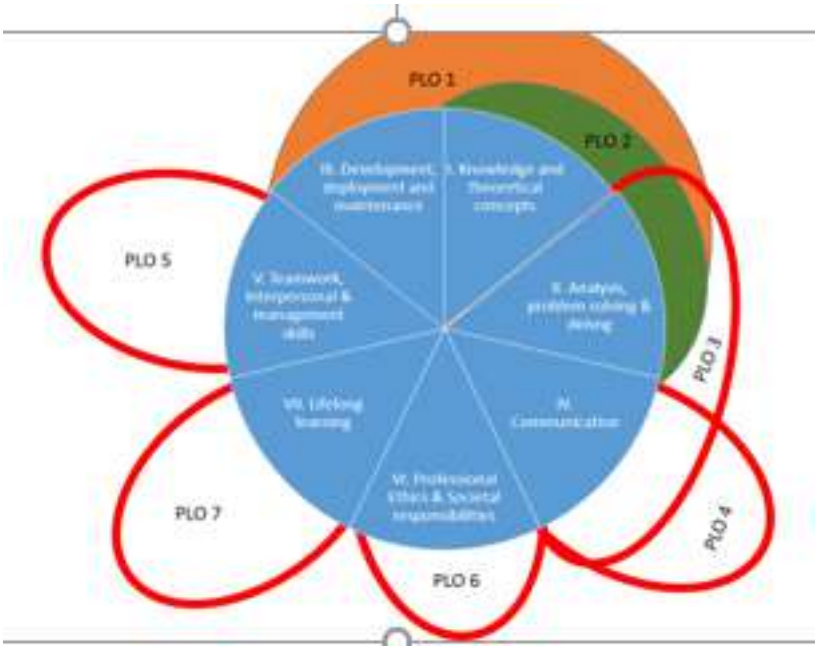

Fig. 1
Connection of PLOs (Tuning) with the different dimensions of the meta-profile

Programme-Level Learning Outcomes (minimum 1 - maximum 3 per competence/ meta-profile element)

6

Structure of the programme: units/courses/modules with their learning outcomes and learning, teaching and assessment strategies

List the courses/modules/units that make up the programme; for each of the courses/modules/units, formulate its intended learning outcomes (in third singular person), as well as teaching, learning and assessment strategies used to ensure that students achieve the unit learning outcomes. Check the alignment within each unit. Questions:

1	Is there a list of the courses/papers that make up the programme?
2	Is information about intended learning outcomes and teaching, learning and assessment strategies provided for each course?
3	Are teaching and learning activities appropriate for the learning outcomes of each course?
4	Can the assessment methods used in each course (a) promote and (b) measure the achievement of all the course learning outcomes?
5	Are course-level learning outcomes, teaching and learning activities and assessment tasks aligned logically?
6	Is there a general balance (no excessive repetition or excessive variety) in teaching, learning and assessment strategies across the different programme courses?

Full response must contain:

- List of all units/modules/courses that constitute the programme you are focusing on
- Course Learning Outcomes for each unit/module/course
- Brief description for Teaching, Learning and Assessment (TLA) activities for each unit/module/course
- More detail on TLA for the courses where the competences you focus on are addressed and the units/modules/courses whose 'implementation' in the revised version you will be monitoring

A detailed structure of the courses, their division over the 4 semesters, the detailed syllabi for each course are provided in the file titled "MTech_CSE_Syllabus_June2019". The following points may be noted -

i) Each course is divided into four modules

ii) At least six course outcomes are provided for each theory course which is a credit course

iii) The number of course outcomes for a Lab course varies from three to five.

UNIT/MODULE/ COURSE	Course Learning Outcomes (CO)	Program Learning Outcomes (PLO)
Advanced Data Structure (CSEN 5101)	On completion of the course the students undergoing this course are able to: 1. Remember definitions and notations of basic terminologies used in data structures. 2. Learn and understand abstract data types and its significance; differentiate between linear and non-linear data structures for solving real world problems. 3. Understand and apply some of the special trees, Tries data structure and various Hashing Techniques 4. Design modular algorithms on linear and non linear data structures for solving engineering problems efficiently. 5. Understand and analyze the basic principles of different string matching algorithms and identify their advantages and disadvantages. 6. Evaluate the performance of different data structures with respect to various applications.	PLO1, PLO2, PLO7
Research Methodology and IPR (CSEN5102)	On completion of the course the students undergoing this course are able to: 1. Understand some basic concepts of research and its methodologies 2. Identify appropriate research topics 3. Select and define appropriate research problem and parameters 4. Prepare a project proposal (to undertake a project) 5. Organize and conduct research (advanced project) in a more appropriate manner 6. Write a research report and thesis	PLO1, PLO2, PLO3, PLO4, PLO6, PLO7

UNIT/MODULE/ COURSE	Course Learning Outcomes (CO)	Program Learning Outcomes (PLO)
Advanced Discrete Mathematics and Statistical Methods (MATH5101)	After completing the course, the student will be able to: 1. Describe the way of writing mathematical model for real-world optimization problems. 2. Identify Linear Programming Problems and their solution techniques 3. Categorize Transportation and Assignment problems 4. Apply the way in which Game Theoretic Models can be useful to a variety of real-world scenarios in economics and in other areas. 5. Convert practical situations into non-linear programming problems. 6. Solve unconstrained and constrained programming problems using analytical techniques.	PLO1, PLO2
Machine Learning (CSEN5131)	On completion of the course the student should be able to: 1. Learn and understand various machine learning algorithms; 2. Understand complexity of Machine Learning algorithms and their limitations; 3. Compare and contrast various machine learning techniques and to get an insight of when to apply a particular machine learning approach; 4. Mathematically analyze various machine learning approaches and paradigms; 5. Apply common Machine Learning algorithms in practice and implementing their own; 6. Perform experiments in Machine Learning using real-world data	PLO1, PLO2, PLO7
Advanced Wireless and Mobile Networks (CSEN5132)	On completion of the course the student should be able to: 1. Learn the wireless/mobile market and the future needs and challenges. 2. Understand the state-of-the-art in network protocols, architectures and applications. 3. Understand the foundation of understanding and working for future generation of wireless systems 4. Understand the concept of Continuous Time Markov Chain (CTMC) 5. Learn to analyze the quality of a network. 6. Acquire the ability to design new protocols for wireless networks and analyse them.	PLO1, PLO2, PLO7
Data Science (CSEN5141)	On completion of the course the student should be able to: 1. Explain how data is collected, managed and stored for data science; 2. Understand the key concepts in data science, including their real-world applications and some of the popular techniques used by data scientists; 3. Build skills in data management; 4. Demonstrate proficiency with statistical analysis of data; 5. Develop ability to build and assess data-based models; 6. Apply data science concepts and methods to solve real-world problems;	PLO1, PLO2, PLO7

UNIT/MODULE/ COURSE	Course Learning Outcomes (CO)	Program Learning Outcomes (PLO)
Distributed Systems (CSEN5142)	Upon successful completion of this course students should be able to: 1. Identify the introductory distributed database concepts and its structures, and relate the importance and application of emerging database technology 2. Describe terms related to distributed object database design and management. 3. Produce the transaction management and query processing techniques in DDBMS. 4. Demonstrate knowledge of the basic elements and concepts related to distributed system technologies 5. Demonstrate knowledge of the core architectural aspects of distributed systems and underlying components of distributed systems (such as RPC, file systems) 6. Design and implement distributed applications and demonstrate experience in building large-scale distributed applications 7. Use and apply important methods in distributed systems to support scalability and fault tolerance	PLO1, PLO2, PLO7
Disaster Management (DIMA5116)	After the completion of this course, students should be able to: 1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response. 2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. 3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. 4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.	PLO1, PLO7
Advanced Algorithms (CSEN5201)	After completion of the course, students would be able to: 1. Remember time complexities of various existing algorithms in different situations 2. Understand the basic principles of different paradigms of designing algorithms 3. Apply mathematical principles to solve various problems 4. Analyze the complexities of various algorithms 5. Evaluate the performance of various algorithms in best case, worst case and average case 6. Create/ Design a good algorithm for a new problem given to him/ her	PLO1, PLO2, PLO7

UNIT/MODULE/ COURSE	Course Learning Outcomes (CO)	Program Learning Outcomes (PLO)
Soft Computing (CSEN5202)	After completion of course, students would be able to: 1. Learn (remember) and understand soft computing techniques and their roles in building intelligent machines. 2. Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems. 3. Design (create) methodology to solve optimization problems using genetic algorithms 4. Analyze and evaluate solutions by various soft computing approaches for a given problem. 5. Understand various models of artificial neural networks and their applications in solving pattern recognition and machine learning problems. 6. Develop intelligent systems leveraging the paradigm of soft computing techniques.	PLO1, PLO2, PLO7
Theory of Computation (CSEN5234)	Students who complete the course will demonstrate the ability to do the followings: 1. Design and analyze Deterministic and non-deterministic finite state automata. 2. Understand the correspondence between finite state automata and regular languages. 3. Design context free grammars to generate strings from a context free language and convert them into Chomsky normal forms. 4. Design deterministic and non-deterministic push down automata to recognize context free languages. 5. Construct Touring machines for computable functions. 6. Understand the hierarchy of formal languages, grammars and machines. 7. Distinguish between computability and non-computability and Decidability and undecidability.	PLO1, PLO2, PLO5, PLO7
Computational Geometry (CSEN5235)	Students who complete the course will demonstrate the ability to do the followings: 1. Know the common algorithms for solving well-known geometric algorithms. 2. Explain the major geometric algorithms and their analyses. 3. Apply a geometric problem or rather identify whether an algorithm for an existing geometric problem can be useful to solve the problem at hand. 4. Estimate the time and space required for implementing a geometric algorithm to solve a new problem. 5. Weigh between different geometric algorithms to solve a given problem. 6. Develop new algorithms for simple geometric problems.	PLO1, PLO2, PLO5, PLO7

UNIT/MODULE/ COURSE	Course Learning Outcomes (CO)	Program Learning Outcomes (PLO)
Graph Algorithms (CSEN5242)	Students who complete the course will demonstrate the ability to do the followings. 1. Learn the advanced concepts and key features of Graph algorithms. 2. Understand the algorithmic approach to Graph related problems. 3. Explain and analyze the major graph algorithms. 4. Employ graphs to model engineering problems, when appropriate. 5. Defend and argue the application of the specific algorithm to solve a given problem. 6. Synthesize new algorithms that employ graph computations as key components, and analyze them. 7. Hypothesize for a critical problem, where graph is involved as an absolutely necessary component.	PLO1, PLO2, PLO5, PLO7
Cloud Computing (CSEN5243)	Students who complete the course will demonstrate the ability to do the followings. 1. Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud. 2. Describe the core issues of cloud computing such as security, privacy, and interoperability to choose the appropriate technologies, algorithms, and approaches for the identified problems. 3. Analyze various cloud computing solutions. 4. Evaluate cloud Storage systems and Cloud security, the risks involved, its impact. 5. Apply knowledge for solving real life cloud computing problem scenario and illustrate solutions. 6. Develop appropriate cloud computing solutions and recommendations according to the applications used.	PLO1, PLO2, PLO7
Term Paper and Seminar (CSEN5293)	After completion of the course student should be able to: 1. Acquire good communication skills 2. Know how to present a topic interestingly in front of audience 3. Convey a completely new technical topic to the audience of which the audience is not completely aware of.	PLO3, PLO4, PLO5
Information Retrieval (CSEN6137)	After completion of course, students would be able to: 1. Identify basic theories and analysis tools as they apply to information retrieval. 2. Develop understanding of problems and potentials of current IR systems. 3. Learn and appreciate different retrieval algorithms and systems. 4. Apply various indexing, matching, organizing, and evaluating methods to IR problem 5. Be aware of current experimental and theoretical IR research. 6. Analyze and design solutions for some practical problems.	PLO1, PLO2, PLO7

UNIT/MODULE/ COURSE	Course Learning Outcomes (CO)	Program Learning Outcomes (PLO)
Social Network Analysis (CSEN6138)	After completion of the course student should be able to: 1. Students should be able to demonstrate basic knowledge of social networks and related application-oriented models. 2. Students should be able to understand applications of graph algorithms in social networks. 3. Students should be able to write programs to implement the related social network analysis algorithms when necessary. 4. Students should be accustomed to various network related libraries (in Python/Java/R/C++) to implement social network theories. 5. Students will get an exposure to the present state-of-the-art algorithms and methods in the area of social networks. 6. Exposure to the state-of-the-art algorithms should help the students in pursuing research in areas related to social networks.	PLO1, PLO2, PLO7
Optimization Techniques (MATH6121)	Students who complete the course will demonstrate the ability to do the followings. 1. Describe the way of writing mathematical model for real-world optimization problems. 2. Identify Linear Programming Problems and their solution techniques 3. Categorize Transportation and Assignment problems 4. Apply the way in which Game Theoretic Models can be useful to a variety of real-world scenarios in economics and in other areas. 5. Convert practical situations into non-linear programming problems. 6. Solve unconstrained and constrained programming problems using analytical techniques.	PLO1, PLO2
Dissertation – Phase I (CSEN6195)	After completion of the course student should be able to: 1. Know how to work in a group/ team 2. Acquire some interpersonal communication skills among the group members 3. Overcome the frustrating situations and try to bring it in their favour.	PLO1, PLO2, PLO3, PLO4, PLO5, PLO7
Dissertation – Phase II (CSEN6295)	After completion of the course student should be able to: 1. Know how to work in a group/ team 2. Acquire some interpersonal communication skills among the group members 3. Overcome the frustrating situations and try to bring it in their favour.	PLO1, PLO2, PLO3, PLO4, PLO5, PLO7

7

Length of the programme and student workload

The program is a 2-year course that is divided into 4 semesters, the Fall Semester starts in late July and finishes in the 2nd week of December, the Spring semester starts in the 2nd week of January and finishes at the end of May.

Along with the modules, every course has a table that indicates the total number of hours allotted per week for lecture, tutorial and lab. These can also be found quickly from the consolidated structure that comes in the beginning of the program handout given to the students (also available in the website). We have also mentioned that in the structure of the program that we have presented in point no. 6

In the detailed syllabi for each subject (course) the number of hours required per module is clearly mentioned. This has been decided only after consultation with the members of faculty who has taught that course at least once. The total number of hours spanning four modules typically comes out to be 36 for a 3 credit theory course, assuming that at least 12 working weeks are always available in spite of a typical two week vacation within the Fall semester.

To determine the typical workload outside the classroom we did a private survey from the department (other than what they did for Tuning India) involving all the 11 students of 2019-2021 batch for all the courses that they attended in their 2-year course. Table 1 below shows the workload in hours for independent works, like study/preparation outside the classroom for each of the courses that all the 11 students reported independently. On the basis of these values in Table 1 and the other parameters, student's workload is converted into ECTS credits. Detailed calculations are shown in Table 2 below.

Table 1

Raw data for hours of independent work mentioned by each of the 11 students involved

Course Code	Course Name	Student										
		1	2	3	4	5	6	7	8	9	10	11
CSEN 5101	Advanced Data Structures	90	93	95	110	92	85	100	60	120	70	90
CSEN 5102	Research Methodology and IPR	40	38	40	50	40	35	50	40	40	80	40
MATH5101	Advanced Discrete Mathematics and Statistical Methods	90	96	90	100	100	85	90	80	60	85	90
CSEN5131	Machine Learning	100	106	120	120	105	95	130	90	120	80	100
CSEN5132	Advanced Wireless and Mobile Networks	Elective not opted by any student of this batch										
CSEN5141	Data Science	50	55	50	90	80	45	60	40	50	70	50
CSEN5142/ CSEN5143	Distributed Systems/ Wireless Sensor Networks	Elective not opted by any student of this batch										
DIMA5116	Disaster Management	10	10	10	40	10	10	10	10	12	60	10
CSEN5151	Advanced Data Structures Lab	90	50	95	100	60	85	100	80	70	80	90
CSEN5181	Machine Learning Lab	100	50	120	120	60	85	120	80	70	80	100
CSEN5182	Advanced Wireless and Mobile Networks Lab	Elective not opted by any student of this batch										
CSEN5201	Advanced Algorithms	90	90	100	120	90	85	110	90	120	70	90
CSEN5202	Soft Computing	90	95	60	110	95	85	100	90	60	90	90
CSEN5231	Data Pre-processing and Analysis	50	40	60	90	80	45	90	50	60	90	50
CSEN5234	Theory of Computation	50	95	70	100	60	45	110	40	60	85	50
CSEN5244	Algorithms for VLSI CAD	50	55	50	100	50	45	90	40	60	60	50
CSEN5251	Advanced Algorithms Lab	90	50	100	120	50	85	100	90	65	70	90
CSEN5252	Soft Computing Lab	90	50	90	120	50	85	105	80	65	80	100
CSEN5293	Term Paper and Seminar	100	110	100	100	105	80	120	100	40	85	100
CSEN6137	Information Retrieval	90	100	70	110	100	80	100	90	65	80	90
MATH6121	Optimization Techniques	50	100	90	100	100	45	100	80	90	90	100
CSEN6195	Dissertation – Phase I	100	115	120	160	110	100	110	100	120	80	100
CSEN6295	Dissertation – Phase II	100	120	140	170	110	100	110	100	120	90	110
CSEN6297	Comprehensive Viva-voce	50	60	30	50	50	50	90	50	40	70	50

Table 2
ECTS credit conversion

Year	Semester	Course Code	Course Name	Students' Workload, hours			Total Students' Workload (1+2+3), hours (4)	ECTS Credits(Cell (4) / 30)
				Contact hours (Guided Learning, face to face activities, lectures, labs, tutorials, etc) (1)	Independent work (self-learning, non-face-to-face activities, revision, homework, etc) (2)	Others: Continuous Assessment (Test, Quiz, Final Exam) (3)		
1st	1st	CSEN5101	Advanced Data Structures	39	91.36	5	135.36	4.51
1st	1st	CSEN5102	Research Methodology and IPR	26	44.82	5	75.82	2.53
1st	1st	MATH5101	Advanced Discrete Mathematics and Statistical Methods	39	87.82	5	131.82	4.39
1st	1st	CSEN5131	Machine Learning	39	106.00	5	150.00	5.00
1st	1st	CSEN5132	Advanced Wireless and Mobile Networks (Elective not opted by any student)	39	0.00	5	0.00	0.00
1st	1st	CSEN5141	Data Science	39	58.18	5	102.18	3.41
1st	1st	CSEN5142/ CSEN5143	Distributed Systems/ Wireless Sensor Networks (Elective not opted by any student)	39	0.00	5	0.00	0.00
1st	1st	DIMA5116	Disaster Management	26	17.45	5	48.45	1.62
1st	1st	CSEN5151	Advanced Data Structures Lab	26	81.82	3	110.82	3.69
1st	1st	CSEN5181	Machine Learning Lab	26	89.55	3	118.55	3.95
1st	1st	CSEN5182	Advanced Wireless and Mobile Networks Lab (Elective not opted by any student)	26	0.00	3	0.00	0.00
1st	2st	CSEN5201	Advanced Algorithms	39	95.91	5	139.91	4.66
1st	2nd	CSEN5202	Soft Computing	39	87.73	5	131.73	4.39
1st	2nd	CSEN5231	Data Preprocessing and Analysis	39	64.09	5.0	108.09	3.60
1st	2nd	CSEN5234	Theory of Computation	39	69.55	5.0	113.55	3.78

Year	Semester	Course Code	Course Name	Students' Workload, hours			Total Students' Workload (1+2+3), hours (4)	ECTS Credits(Cell (4) / 30)
				Contact hours (Guided Learning, face to face activities, lectures, labs, tutorials, etc) (1)	Independent work (self-learning, non-face-to-face activities, revision, homework, etc) (2)	Others: Continuous Assessment (Test, Quiz, Final Exam) (3)		
1st	2nd	CSEN5244	Algorithms for VLSI CAD	39	59.09	5.0	103.09	3.44
1st	2nd	CSEN5251	Advanced Algorithms Lab	26	82.73	3.0	111.73	3.72
1st	2nd	CSEN5252	Soft Computing Lab	26	83.18	3.0	112.18	3.74
1st	2nd	CSEN5293	Term Paper and Seminar	26	94.55	1.0	121.55	4.05
2nd	1st	CSEN6137	Information Retrieval	39	88.64	5.0	132.64	4.42
2nd	1st	MATH6121	Optimization Techniques	39	85.91	5.0	129.91	4.33
2nd	1st	CSEN6195	Dissertation – Phase I	260	110.45	1.0	371.45	12.38
2nd	2nd	CSEN6295	Dissertation – Phase II	364	115.45	1.0	480.45	16.02
2nd	2nd	CSEN6297	Comprehensive Viva-voce	N/A	53.64	0.5	54.14	1.80
						Total ECTS Credits in 2 years		99.45

8

Overall consistency of the programme

The mappings of the Course Outcomes or COs (which is basically the same as the Unit-level Learning Outcomes) with the Programme Level Learning Outcomes or PLOs as well as the list of competences (both Generic and Subject-specific) are presented below in full detail.

It is clear from the following table that each course of the programme is mapped to at least one programme-level learning outcome (PLO). It can also be noted from the table that there is no PLO left which is not covered by any courses of the programme.

The progression of course learning outcomes towards the development of each PLO is monitored from the performance of the students in the semester examination and other direct and indirect methods. If it is shown that for a particular course, the set of PLOs supposed to be achieved, are not actually achieved, then necessary measures are taken. This is discussed to some extent in point 9 of this document.

It can be concluded from the following table that almost all the PLOs are addressed by a number of courses of the programme, except PLO5. This PLO is hence planned to be properly addressed in the course named as 'Term Paper and Seminar' (CSEN5293).

Mapping of COs (same as Unit LOs) - with PLOs and General Competences

Units	Unit LOs	G1		G4	G6	G9		G14	G15	G21	G26		G28
		PLO1	PLO2	PLO2	PLO7	PLO4	PLO5	PLO4	PLO5	PLO1	PLO1	PLO2	PLO5
CSEN 5101	CO1				√								
	CO2				√								
	CO3	√			√					√	√		
	CO4	√	√	√						√	√	√	
	CO5	√	√	√	√					√	√	√	
	CO6	√								√	√		

Units	Unit LOs	G1		G4	G6	G9		G14	G15	G21	G26		G28
		PLO1	PLO2	PLO2	PLO7	PLO4	PLO5	PLO4	PLO5	PLO1	PLO1	PLO2	PLO5
CSEN 5102	CO1				√								
	CO2		√	√								√	
	CO3		√	√								√	
	CO4												
	CO5	√	√	√		√		√		√	√	√	
	CO6												
MATH 5101	CO1		√	√								√	
	CO2		√	√								√	
	CO3		√	√								√	
	CO4	√	√	√						√	√	√	
	CO5		√	√								√	
	CO6	√								√	√		
CSEN 5131	CO1				√								
	CO2				√								
	CO3				√								
	CO4	√								√	√		
	CO5	√	√	√						√	√	√	
	CO6	√								√	√		
CSEN 5132	CO1				√								
	CO2				√								
	CO3				√								
	CO4				√								
	CO5				√								
	CO6	√	√	√						√	√	√	
CSEN 5141	CO1				√								
	CO2				√								
	CO3				√								
	CO4				√								
	CO5				√								
	CO6	√	√	√						√	√	√	

Units	Unit LOs	G1		G4	G6	G9		G14	G15	G21	G26		G28
		PLO1	PLO2	PLO2	PLO7	PLO4	PLO5	PLO4	PLO5	PLO1	PLO1	PLO2	PLO5
CSEN 5142	CO1				√								
	CO2				√								
	CO3				√								
	CO4				√								
	CO5				√								
	CO6	√	√	√						√	√	√	√
	CO7	√	√	√						√	√	√	√
DIMA 5116	CO1				√								
	CO2	√								√	√		
	CO3				√								
	CO4				√								
CSEN 5201	CO1				√								
	CO2				√								
	CO3	√	√	√	√					√	√	√	
	CO4	√								√	√		
	CO5	√								√	√		
	CO6		√	√								√	
CSEN 5202	CO1				√								
	CO2	√								√	√		
	CO3	√	√	√						√	√	√	
	CO4		√	√								√	
	CO5				√								
	CO6				√								
CSEN 5234	CO1	√	√	√						√	√	√	
	CO2	√	√	√	√					√	√	√	
	CO3	√	√	√						√	√	√	√
	CO4	√	√	√						√	√	√	√
	CO5	√	√	√						√	√	√	√
	CO6	√	√	√	√					√	√	√	
	CO7		√	√	√							√	

Units	Unit LOs	G1		G4	G6	G9		G14	G15	G21	G26		G28
		PLO1	PLO2	PLO2	PLO7	PLO4	PLO5	PLO4	PLO5	PLO1	PLO1	PLO2	PLO5
CSEN 5235	CO1				√								
	CO2		√	√								√	
	CO3	√	√							√	√		
	CO4	√	√							√	√	√	√
	CO5	√	√							√	√	√	√
	CO6				√								
CSEN 5242	CO1				√								
	CO2				√								
	CO3	√	√	√						√	√	√	√
	CO4	√	√	√						√	√	√	√
	CO5	√	√	√						√	√	√	√
	CO6	√	√	√						√	√	√	√
	CO7	√	√	√						√	√	√	√
CSEN 5243	CO1		√	√								√	
	CO2		√	√								√	
	CO3	√	√	√						√	√	√	
	CO4		√	√								√	
	CO5				√								
	CO6				√								
CSEN 5293	CO1					√		√					
	CO2					√	√	√	√				√
	CO3					√		√					
	CO4												
CSEN 6137	CO1		√	√								√	
	CO2				√								
	CO3				√								
	CO4	√	√	√						√	√	√	
	CO5				√								
	CO6	√	√	√						√	√	√	

Units	Unit LOs	G1		G4	G6	G9		G14	G15	G21	G26		G28
		PLO1	PLO2	PLO2	PLO7	PLO4	PLO5	PLO4	PLO5	PLO1	PLO1	PLO2	PLO5
CSEN 6138	CO1				√								
	CO2				√								
	CO3	√	√	√						√	√	√	
	CO4				√								
	CO5	√	√	√	√					√	√	√	
	CO6	√	√	√	√					√	√	√	
MATH 6121	CO1		√	√								√	
	CO2	√	√	√						√	√	√	
	CO3		√	√								√	
	CO4		√	√								√	
	CO5		√	√								√	
	CO6	√	√							√	√		
CSEN 6195	CO1						√		√				√
	CO2					√		√					
	CO3	√	√	√	√	√		√		√	√	√	
CSEN 6195	CO1						√		√				√
	CO2					√		√					
	CO3	√	√	√	√	√		√		√	√	√	

Mapping of COs (same as Unit LOs) – with PLOs and Subject Specific Competences

Units	Unit LOs	S1		S5		S6	S8	S11		S12
		PLO1	PLO2	PLO2	PLO3	PLO1	PLO1	PLO1	PLO2	PLO6
CSEN 5101	CO1									
	CO2									
	CO3	√				√	√	√		
	CO4	√	√	√		√	√	√	√	
	CO5	√	√	√		√	√	√	√	
	CO6	√				√	√	√		

Units	Unit LOs	S1		S5		S6	S8	S11		S12
		PLO1	PLO2	PLO2	PLO3	PLO1	PLO1	PLO1	PLO2	PLO6
CSEN 5102	CO1									
	CO2		√	√					√	
	CO3		√	√					√	
	CO4				√					
	CO5	√	√	√		√	√	√	√	√
	CO6				√					
MATH 5101	CO1		√	√					√	
	CO2		√	√					√	
	CO3		√	√					√	
	CO4	√	√	√		√	√	√	√	
	CO5		√	√					√	
	CO6	√				√	√	√		
CSEN 5131	CO1									
	CO2									
	CO3									
	CO4	√				√	√	√		
	CO5	√	√	√		√	√	√	√	
	CO6	√				√	√	√		
CSEN 5132	CO1									
	CO2									
	CO3									
	CO4									
	CO5									
	CO6	√	√	√		√	√	√	√	
CSEN 5141	CO1									
	CO2									
	CO3									
	CO4									
	CO5									
	CO6	√	√	√		√	√	√	√	

Units	Unit LOs	S1		S5		S6	S8	S11		S12
		PLO1	PLO2	PLO2	PLO3	PLO1	PLO1	PLO1	PLO2	PLO6
CSEN 5142	CO1									
	CO2									
	CO3									
	CO4									
	CO5									
	CO6	√	√	√		√	√	√	√	
	CO7	√	√	√		√	√	√	√	
DIMA 5116	CO1									
	CO2	√				√	√	√		
	CO3									
	CO4									
CSEN 5201	CO1									
	CO2									
	CO3	√	√	√		√	√	√	√	
	CO4	√				√	√	√		
	CO5	√				√	√	√		
	CO6		√	√	√				√	
CSEN 5202	CO1									
	CO2	√				√	√	√		
	CO3	√	√	√		√	√	√	√	
	CO4		√	√					√	
	CO5									
	CO6									
CSEN 5234	CO1	√	√	√		√	√	√	√	
	CO2	√	√	√		√	√	√	√	
	CO3	√	√	√		√	√	√	√	
	CO4	√	√	√		√	√	√	√	
	CO5	√	√	√		√	√	√	√	
	CO6	√	√	√		√	√	√	√	
	CO7		√	√					√	

Units	Unit LOs	S1		S5		S6	S8	S11		S12
		PLO1	PLO2	PLO2	PLO3	PLO1	PLO1	PLO1	PLO2	PLO6
CSEN 5235	CO1									
	CO2		√	√					√	
	CO3	√				√	√	√		
	CO4	√				√	√	√		
	CO5	√				√	√	√		
	CO6									
CSEN 5242	CO1									
	CO2									
	CO3	√	√	√		√	√	√	√	
	CO4	√	√	√		√	√	√	√	
	CO5	√	√	√		√	√	√	√	
	CO6	√	√	√		√	√	√	√	
	CO7	√	√	√		√	√	√	√	
CSEN 5243	CO1		√	√					√	
	CO2		√	√					√	
	CO3	√	√	√		√	√	√	√	
	CO4		√	√					√	
	CO5									
	CO6									
CSEN 5293	CO1									
	CO2									
	CO3									
	CO4				√					
CSEN 6137	CO1									
	CO2									
	CO3									
	CO4	√	√	√		√	√	√	√	
	CO5									
	CO6	√	√	√		√	√	√	√	

Units	Unit LOs	S1		S5		S6	S8	S11		S12
		PLO1	PLO2	PLO2	PLO3	PLO1	PLO1	PLO1	PLO2	PLO6
CSEN 6138	CO1									
	CO2									
	CO3	√	√	√		√	√	√	√	
	CO4									
	CO5	√	√	√		√	√	√	√	
	CO6	√	√	√		√	√	√	√	
MATH 6121	CO1									
	CO2	√	√	√		√	√	√	√	
	CO3									
	CO4									
	CO5									
	CO6	√				√	√	√		
CSEN 6195	CO1									
	CO2									
	CO3	√	√	√		√	√	√	√	
CSEN 6195	CO1									
	CO2									
	CO3	√	√	√		√	√	√	√	

9

Internal Quality Control/Enhancement

In our department, generally, all gross academic decisions related to the department are discussed in our Board of Studies, which consists of all the departmental staff (i.e. faculty members along with the teaching assistants) and three external experts with representations from both industries as well as academia. All decisions related to change in curriculum and/ or program delivery is then reviewed by the institute Academic Council that consists of representatives from all the academic departments along with a pool of external members consisting of renowned Professors from institutes of national (maybe international also) repute and leaders from local industry. Apart from this, a separate committee at the institute level named Internal Quality Assurance Committee (IQAC) keeps a watch over the academic activities, time to time. All three committees mentioned above typically meets at least once in three months.

Now the change that we are planning to bring in our Masters program, was obviously discussed in our Board of Studies, and the identification of the domains in the meta-profile that require attention was done by six experienced members of the departmental faculty and hence can also be attributed to be a contribution of the Board of Studies of the department.

Gap found: When we mapped our existing course to the meta-profile formulated by Tuning India, we found a strong correlation with all the other dimensions except the 5th one – 'Teamwork, Interpersonal & Management skills'. Hence this is the gap we planned to address.

Improvement suggested: We could zero in on the gap further when we found that while there was provision for the students to develop their interpersonal and managerial skills as a part of the curriculum, there was no course that directly addressed the need for learning the skills related to teamwork. We pondered over the different possible ways to bridge the identified gap and finally decided to introduce the option for teamwork in practice instead of loading the students with another theory paper and hence modified the course requirements of a sessional paper titled: 'Term Paper and Seminar'.

Implementation Plan: We thought that in the delivery of this module termed 'Term Paper and Seminar', in which earlier they used to work alone, we will make the students form groups of at least two or three. Each group may preferably include students who have some similarity in the domain where they decide to work for their final year thesis. We can make one of them the leader or maybe each of them a leader for a particular job, say literature study, preparation of the term paper, preparation of the slides and finally delivering the

seminar. Since the number of students is less in Masters, it is possible to arrange for multiple seminars for each student and generally, that is what the norm is. We finally decided that each student will first deliver a seminar on her own and later in the next cycle, they will prepare and deliver as a group – which will help us to measure the effectiveness of the change introduced even better.

Analysis of the feedback: This will be done mainly by a small group of faculties from the department including the faculty member who will be directly involved in coordinating the implementation plan. They are going to do this through direct and indirect assessments of the Course Outcomes (CO) and Program Outcomes (PO). However, the feedback from the students involved in the course will also be considered. Also, note that we take the feedback from the alumni and also other stakeholders like employers or parents of students from time to time (maybe once in a year or once in 3 semesters) on our overall program as a part of our accreditation process. However, this being a new initiative might not get evaluated by such stakeholders in near future.

10

Other Relevant Aspects

In our institution, we have to maintain some uniformity amongst the five different Masters courses that are offered – like total credits, credits per semester, credit allotted to the dissertation, seminar, etc., number of Electives, and number of Open (Cross-departmental) Electives. Whatever we want to do with our program, we have to maintain uniformity in the above-mentioned criteria, otherwise, we may not get approval from the Academic Council, even if we can get the concurrence of the Board of Studies. Under the above norms, if we wanted to introduce a new theory paper on 'Team Work', (if one looks carefully) the only place we could introduce this is in the 1st semester, and that too as an Audit course. Further note that this bucket of audit courses already has a course called Disaster Management, which is quite popular so much so that for the last couple of years all the students opted for it and that this course does teach them some management skills. If we put this new course on teamwork, in the same bucket, the students could attend only one of them. Hence in order to make some Learning Outcomes strong, some others would have been weakened. Hence, we finally concluded that the best place to implement the gap in teamwork would be that sessional paper where the students will learn through execution, after all, who will not agree that real-life examples are better than precepts.

11

Example of Students' Learning Guide

M. Tech in CSE, HIT, Kolkata, India

Students' Learning Guide

1. Introduction to the Subject: Advanced Algorithms (CSEN5201) (1st Year, 2nd Semester)

1.1. *Lecturer's contact details*

Prof. (Dr.) AmitavaBagchi

Email: amitava.bagchi@heritageit.edu (taught in 2020)

Prof. (Dr.) Subhashis Majumder

Email: subhashis.majumder@heritageit.edu (taught in 2019) and

Prof. Sujay Saha

Email: sujay.saha@heritageit.edu (taught in 2019)

1.2. *Contribution to the degree profile*

This subject is one of the core courses as far as M. Tech. degree in Computer Science and Engineering is concerned. It builds up the basic knowledge for analyzing algorithms that are written using different paradigms, the principles of various algorithm design techniques, concepts of NP-completeness and approximation algorithms etc. to every graduate. These

knowledges are very much essential for understanding the content of the courses like Machine Learning, Natural Language Processing, Data Science etc. in the later semesters. With that the subject develops all the generic and specific competences to the graduates. The aim of this course is to help the students to increase their ability to design good algorithms for the given new problems and to analyze the complexities of that algorithm in all possible cases.

1.3. *Competences to be developed*

Generic Competences

G1: Ability to do research

PLO 1: solve practical problems by independently carrying out research/investigation and development work

PLO 2: define the problems formally for research and implement using appropriate theoretical concepts

G4: Ability to apply knowledge in practical situations

PLO 2: define the problems formally for research and implement using appropriate theoretical concepts

G6: Be a life-long learner

PLO7: develop the skill and attitude for self-learning towards comprehensive understanding of current technology and knowledge-set for continuous professional development

G21: Be adaptable to emerging trends

PLO 1: solve practical problems by independently carrying out research/investigation and development work

G26: Ability to use available resources optimally and efficiently

PLO 1: solve practical problems by independently carrying out research/investigation and development work

PLO 2: define the problems formally for research and implement using appropriate theoretical concepts

Specific Competences

S1: Applying knowledge of mathematical principles, algorithms and computer sciences to identify requirements, define, analyze and solve problems

PLO 1: solve practical problems by independently carrying out research/investigation and development work

PLO 2: define the problems formally for research and implement using appropriate theoretical concepts

S5: Design of ICT systems, including modeling (formal description) of their structure and processes

PLO 2: define the problems formally for research and implement using appropriate theoretical concepts

PLO 3: produce and present a substantial technical report/document for concerned people in the appropriate knowledge domain

S6: Deploy, install, integrate, put into service and maintain ICT systems and their elements

PLO 1: solve practical problems by independently carrying out research/investigation and development work

S8: Develop ICT systems in compliance with industry specifications, standards and recommendations

PLO 1: solve practical problems by independently carrying out research/investigation and development work

S11: Identify security threats and provide effective methods for information security

PLO 1: solve practical problems by independently carrying out research/investigation and development work

PLO 2: define the problems formally for research and implement using appropriate theoretical concepts

2. Student Work Plan

2.1. *Distribution of activities and workload*

Competence	Contents	Activities-Resources-Documentation	Estimated work time		Completion and/ or submission deadlines
			Contact hours	Independent work	
G4: Ability to apply knowledge in practical situations G26: Ability to use available resources optimally and efficiently S1: Applying knowledge of mathematical principles, algorithms and computer sciences to identify requirements, define, analyse and solve problems S5: Design of ICT systems, including modeling (formal description) of their structure and processes S6: Deploy, install, integrate, put into service and maintain ICT systems and their elements S8: Develop ICT systems in compliance with industry specifications, standards and recommendations	**Module I** **a) Basic Concepts** **b) Sorting and Selection** **c) Searching**	All the lecture materials/ resources will be shared with the students either in the form of PPTs or as handwritten documents	**Module I (9hrs)**	**Module I (16hrs)**	
		Lecturer gives a brief introduction about the subject – outcomes of this course (COs), student's learning guide, degree profile, generic and specific competencies and the associated program-level learning outcomes (PLOs)	30 mins.		Week 1
		Students discusses about the mentioned competences with each other	15 mins.		Week 1
		Module I (a) start with the introductory lecture by the instructor	**Module I(a) 2 hrs. 15 min**	1 hr.	Week 1
		Basic ideas of complexity analysis - best case, worst case and average case, with suitable examples	30 mins.	1 hr.	Week 1
		Significance of asymptotic notations, like big-oh, big-omega, big-theta, small-o etc.	30 mins.	2 hr. 30 mins.	Week 2
		Discussion on recurrences, recurrence relations, solutions with examples etc.	1 hr. 15 mins.		Week 2
		Module I (b) start with the introductory lecture by the instructor	**Module I(b) 4 hrs.**	3 hrs.	Week 2
		Discussion of Merge sort and Heap sort with their analysis	1 Hr. 20 mins	3 hrs.	Week 3
		Analysis of Quick sort and lower bound theory	1 Hr. 20 Mins	3 hrs.	Week 3
		Discussion on median order statistic	1 Hr. 20 mins		Week 3
		Module I (c) start with the introductory lecture by the instructor	**Module I(c) 2 hrs.**	2 hrs. 30 mins.	Week 3
		Discussion on Linear and Binary Search with their analysis	1 hr. 30 mins		
		Instructor discusses about possible questions from Module I with the students	30 mins		

Competence	Contents	Activities-Resources-Documentation	Estimated work time		Completion and/ or submission deadlines
			Contact hours	Independent work	
G1: Ability to do research G4: Ability to apply knowledge in practical situations G26: Ability to use available resources optimally and efficiently S1: Applying knowledge of mathematical principles, algorithms and computer sciences to identify requirements, define, analyse and solve problems S5: Design of ICT systems, including modeling (formal description) of their structure and processes S6: Deploy, install, integrate, put into service and maintain ICT systems and their elements S8: Develop ICT systems in compliance with industry specifications, standards and recommendations	**Module II** **a) Graph Algorithms** **b) Greedy Method**	All the lecture materials/ resources will be shared with the students either in the form of PPTs or as handwritten documents Module II (a) start with the introductory lecture by the instructor Discussion on DFS and BFS algorithm with their analysis Applications of DFS, like topological sorting and strongly connected components are discussed Module II (b) start with the introductory lecture by the instructor Basic principles of greedy method discussed with the example of knapsack problem Dijkstra's algorithm discussed with example, its analysis MST algorithm Prim's discussed with its analysis Bellman Ford algorithm discussed along with its analysis Kruskal's algorithm discussed Instructor discusses about possible questions from Module II with the students, explains how the model answers are supposed to be etc.	**Module II (9hrs)** **Module II(a) 3 hrs.** 1 hr. 30 mins. 1 hr. 30 mins **Module II(b) 6 hrs.** 1 hr. 1 hr 30 min. 1 hr. 1 hr. 1 hr. 30 mins.	**Module II (12hrs)** 3 hrs. 2 hrs. 1 hr. 3 hrs. 1 hr. 1 hr. 1 hr.	Week 4 Week 4 Week 4 Week 4 Week 5 Week 5 Week 6 Week 6 Week 6

Competence	Contents	Activities-Resources-Documentation	Estimated work time		Completion and/or submission deadlines
			Contact hours	Independent work	
G1: Ability to do research G4: Ability to apply knowledge in practical situations G6: Be a life-long learner G26: Ability to use available resources optimally and efficiently S1: Applying knowledge of mathematical principles, algorithms and computer sciences to identify requirements, define, analyse and solve problems S5: Design of ICT systems, including modeling (formal description) of their structure and processes S6: Deploy, install, integrate, put into service and maintain ICT systems and their elements S8: Develop ICT systems in compliance with industry specifications, standards and recommendations S11: Identify security threats and provide effective methods for information security	**Module III** **a) Dynamic Programming** **b) Algebraic Operations** **c) Amortized Analysis**	All the lecture materials/ resources will be shared with the students either in the form of PPTs or as handwritten documents Module III (a) start with the introductory lecture by the instructor Basic principles of dynamic programming discussed with the example of knapsack problem matrix chain multiplication problem LCS problem Floyd-Warshall algorithm Module III (b) start with the introductory lecture by the instructor GCD computation using Euclid's algorithm Strassen's matrix multiplication algorithm Module III (c) start with the introductory lecture by the instructor Significance of amortized analysis discussed Aggregate method Accounting method Potential method Instructor discusses about possible questions from Module III with the students, explains how the model answers are supposed to be written etc.	**Module III (9hrs)** **Module III (a) 4 hrs.** 45 mins. 1 hr. 30 mins. 1 hr. 45 mins **Module III (b) 2 hrs.** 30 mins. 1 hr. 30 mins. **Module III (c) 3 hrs.** 30 mins. 2 hr. 30 mins.	**Module III (15hrs)** 1 hr. 3 hrs. 2 hrs. 1 hr. 30 mins. 2 hrs. 1 hr. 30 mins. 4 hrs.	Week 7 Week 7 Week 7 Week 7 Week 8 Week 8 Week 8 Week 8 Week 9 Week 9 Week 9

Competence	Contents	Activities-Resources-Documentation	Estimated work time		Completion and/ or submission deadlines
			Contact hours	Independent work	
G1: Ability to do research G4: Ability to apply knowledge in practical situations G6: Be a life-long learner G21: Be adaptable to emerging trends G26: Ability to use available resources optimally and efficiently S1: Applying knowledge of mathematical principles, algorithms and computer sciences to identify requirements, define, analyse and solve problems S5: Design of ICT systems, including modeling (formal description) of their structure and processes S6: Deploy, install, integrate, put into service and maintain ICT systems and their elements S8: Develop ICT systems in compliance with industry specifications, standards and recommendations S11: Identify security threats and provide effective methods for information security	**Module IV** **a) Flows in Networks** **b) NP-completeness** **c) Approximation algorithms** **d) Recent Trends**	All the lecture materials/ resources will be shared with the students either in the form of PPTs or as handwritten documents Module IV (a) start with the introductory lecture by the instructor Basic concepts Ford-Fulkerson method with maxflow – min cut theorem Module IV (b) start with the introductory lecture by the instructor Basic ideas of deterministic and non-deterministic algorithms Definitions of P, NP, NP-complete, NP-Hard discussed Various NP-complete problems along with associated proofs Module IV (c) start with the introductory lecture by the instructor Necessity of approximation schemes Approximation algorithms for various NP-complete problems discussed Module IV (d) start with the introductory lecture by the instructor Some state-of-the-art sorting, searching algorithms by applying recently proposed data structures discussed Instructor discusses about possible questions from Module IV with the students, explains how the model answers are supposed to be written etc. Feedback from students taken regarding the course and the lectures given by the instructor	**Module IV (9hrs)** **Module IV (a) 2 hrs.** 30 mins 1 hr. 30 mins. **Module IV (b) 3 hrs.** 15 mins. 45 mins 2 hrs. **Module IV (c) 2 hrs. 15 min** 15 mins. 2 hrs. **Module IV (d) 1 hr.** 1 hr. 30 mins. 15 mins.	**Module IV (13hrs)** 30 mins. 3 hrs. 30 mins. 1 hr. 3 hrs. 30 mins. 30 min 3 hrs. 1 hr.	Week 10 Week 10 Week 10 Week 10 Week 10 Week 11 Week 11 Week 11 Week 12 Week 12 Week 12 Week 12 Week 12
Total			**36 hours** (i.e. no less than 1/3)	**56 hours** (i.e. up to 2/3)	

2.2. *Summary*

Type of activities	Contact hours	Independent work	Total
Theoretical learning	36	56	92
Practical activities (it is part of a separate module, **Advanced Algorithms Lab(CSEN5251)**) and Assessment	**5** (2 class tests of duration 1 hour each and one final exam of 3 hours)	**6** (4 assignments approximately requiring 1.5 hours each)	
Total	**41**	**62**	**103**

3. Assessment System

3.1. *Table of assessment*

Competence	Assessment technique	Grade
Generic competence **G1**: Ability to do research **Learning Outcomes** **PLO 1:** solve practical problems by independently carrying out research/investigation and development work **PLO 2:** define the problems formally for research and implement using appropriate theoretical concepts	**Assignments – 5%**	**5%**
Generic competence **G4:** Ability to apply knowledge in practical situations **Learning Outcomes** **PLO 2:** define the problems formally for research and implement using appropriate theoretical concepts	**Class Test 1 – 2%** **Class Test 2 – 2%** **Assignments – 2%** **Final Exam – 15%**	**21%**
Generic competence **G6:** Be a life-long learner **Learning Outcomes** **PLO7:** develop the skill and attitude for self-learning towards comprehensive understanding of current technology and knowledge-set for continuous professional development	**Class Test 2 – 1%** **Assignments – 1%** **Final Exam – 5%**	**7%**
Generic competence **G21:** Be adaptable to emerging trends **Learning Outcomes** **PLO 1:** solve practical problems by independently carrying out research/investigation and development work	**Class Test 2 – 1%** **Assignments – 1%** **Final Exam – 5%**	**7%**

Competence	Assessment technique	Grade
Generic competence **G26:** Ability to use available resources optimally and efficiently **Learning Outcomes** **PLO 1:** solve practical problems by independently carrying out research/investigation and development work **PLO 2:** define the problems formally for research and implement using appropriate theoretical concepts	**Class Test 1 – 1%** **Class Test 2 – 1%** **Assignments – 1%** **Final Exam – 15%**	**18%**
Specific competence **S1:** Applying knowledge of mathematical principles, algorithms and computer sciences to identify requirements, define, analyze and solve problems **Learning Outcomes** **PLO 1:** solve practical problems by independently carrying out research/investigation and development work **PLO 2:** define the problems formally for research and implement using appropriate theoretical concepts	**Class Test 1 – 2%** **Class Test 2 – 2%** **Assignments – 1%** **Final Exam – 20%**	**25%**
Specific competence **S5:** Design of ICT systems, including modeling (formal description) of their structure and processes **Learning Outcomes** **PLO 2:** define the problems formally for research and implement using appropriate theoretical concepts **PLO 3:** produce and present a substantial technical report/document for concerned people in the appropriate knowledge domain	**Assignments – 2%**	**2%**
Specific competence **S6:** Deploy, install, integrate, put into service and maintain ICT systems and their elements **Learning Outcome** **PLO 1:** solve practical problems by independently carrying out research/investigation and development work	**Assignments – 1%**	**1%**
Specific competence **S8:** Develop ICT systems in compliance with industry specifications, standards and recommendations **Learning Outcomes** **PLO 1:** solve practical problems by independently carrying out research/investigation and development work	**Class Test 1 – 1%** **Class Test 2 – 1%** **Assignments – 1%** **Final Exam – 5%**	**8%**
Specific competence **S11:** Identify security threats and provide effective methods for information security **Learning Outcomes** **PLO 1:** solve practical problems by independently carrying out research/investigation and development work **PLO 2:** define the problems formally for research and implement using appropriate theoretical concepts	**Class Test 2 – 1%** **Final Exam – 5%**	**6%**

3.2. *Observations of assessment –*

The two class tests (each of 1 hour duration) together contribute to 15 % of the final grade and the take-home assignments together amount to another 15%, whereas the final exam at the end of the semester contributes to rest 70%. Note that the syllabus for this paper is divided into 4 modules of roughly equal amount of content. The final exam paper is of 70 marks with 10 short questions each of 1 mark and a student has to answer 5 broad questions each of 12 marks. The final exam paper is planned in such a way that the student has to answer at least one broad question of 12 marks from each of the four modules. Hence it is very important to have a good grasp over the entire syllabus if one is yearning for any of the top two grades – O (90% or above) or E (80% or above).The final exam is of 3 hours duration.

3.3. *Summary of assessment*

Competence	Continuous assessment			Final assessment	Total
	Class Test 1	Class Test 2	Assignments		
G1			5%		
G4	2%	2%	2%	15%	
G6		1%	1%	5%	
G21		1%	1%	5%	
G26	1%	1%	1%	15%	
S1	2%	2%	1%	20%	
S5			2%		
S6			1%		
S8	1%	1%	1%	5%	
S11		1%		5%	
Total	**30%**			**70%**	**100%**

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