SCHEME OF EXAMINATION

&

SYLLABI

for

Master of Technology
(Two Degree Programmes)
(1st & 2nd Year)

Offered by

University School of Information, Communication and Technology

w.e.f. Academic Session 2022-23

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY

GuruGobindSinghIndraprasthaUniversity
Sector 16C, Dwarka, Delhi – 110 078 [INDIA]
www.ipu.ac.in

With effect from academic session 2022-23.

Approval History:

1. **First semester scheme and syllabus approved by 58th Board of Studies of University School of Information and Communication Technology held on dt. 10.09.2022.**
2. **First semester scheme and syllabus approved by AC Subcommittee held on dt. 14.09.2022.**

Vision of the School

Create high-qualityengineering professionals

Mission of the School

To serve humanity by creatingprofessionally competent, socially sensitiveengineers with high ethical values who canwork as individuals or in groups inmulticultural global environments.

Introduction

This document describes the curriculum of the Master of Technology Programmes that are offered at the University School of Information, Communication and Technology. In the event of any difficulty of implementation, and / or interpretation of any clause of the document, the same may be brought to the notice of Dean of the University School of Information Communication and Technology. The decision of the Dean, University School of Information Communication and Technology shall be final and implemented to resolve the issue. The same shall be put up in the subsequent meeting of the Board of Studies of the University School of Information Communication and Technology for its approval. If the decision of the Board of Studies of the University School of Information Communication and Technology is at variance with the decision taken earlier by the Dean of the School, the decision of the Board shall be effective from the date of the approval by the Board of Studies. In the interim period (between the approval of the Dean, of the School and the Board of Studies approval), the decision already taken by the Dean of the school shall stand.

In view of the admission scenario, these programme of studies shall be offered only at the schools of the University or government institutions affiliated to the University,

The scheme and syllabus defined in this document shall be also applicable to the corresponding Master of Technology programmes of the dual degree scheme.

This document defines the scheme and syllabus of the programmes of study for the following degree nomenclatures or for the following major disciplines:

1. Master of Technology in Computer Science and Engineering (M.Tech. CSE)
2. Master of Technology in Information Technology (M.Tech. IT)
3. Master of Technology in Electronics and Communications Engineering (M.Tech. ECE)
4. Master of Technology in Robotics and Automation Engineering (M.Tech. RA)

Scheme and Syllabus

Course / Paper Group Codes:
HS: Humanities, social science, management
PC: Programme Core, that is course / paper offered in the discipline of the programme as a compulsory paper.
EA: Emerging Area Elective offered by school. This allows a student to opt for Minor Specialization
OA: Open area elective offered by other school or other schools or Swayam /MOOCS

Acronyms:

APC: Academic programme committee comprising of all faculty of the school.
L: Number of Lecture hours per week
P: Number of Practical Hours per week
C: Number of credits assigned to a course / paper
NUES: An evaluation scheme in which evaluation is conducted by a committee, a teacher or a group of teacher as described in the scheme of study.
COE: Controller of Examinations of the Examinations Division of the University.

Master of Technology in Computer Science and Engineering
(2 Year Regular Programme)

Programme Educational Objectives for M.Tech (CSE) Programme

PEO1: To develop students to critically analyze the problems in the field of Computer Science & Engineering and find optimal solutions.
PEO2: To train students to conduct research and experiments by applying appropriate techniques and tools with an understanding of the limitations for sustainable development of society.
PEO3: To prepare students to act as a member and leader of the team to contribute positively to manage projects efficiently in the field of Computer Science & engineering.
PEO4: To train the students to effectively communicate, write reports, create documentation and make presentations by adhering to appropriate standards.
PEO5: To stimulate students for life-long learning with enthusiasm and commitment to improve knowledge and competence continuously.

Program Specific Outcomes for M.Tech (CSE) Programme (PSO)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems
PO2: An ability to write and present a substantial technical report/document
PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PSO-PEO Matrix*

Filled on a scale of 1 to 3 (3=High; 2=Moderate; 1=Low; '-'for no correlation)

Course Outcomes	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	2	2	2
PO2	3	1	2	3	1
PO3	3	3	3	2	3
PO4	1	2	3	2	2

First Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**C**
Theory Papers					
PC	ICT501	Advanced Data Structures	4		4
PC	ICT503	Advanced Software Engineering	4		4
PC	ICT505	Soft Computing	3		3
PC	ICT507	Advanced DBMS	4		4
PC	ICT509	Advances in Data & Computer Communications	4		4
PC	ICT511	Scientific Writing		2	2
Practical/Viva Voce					
PC	ICT551	Lab.-1 (ADS)	-	2	1
PC	ICT553	Lab.-2 (ASE)	-	2	1
PC	ICT555	Lab.-3 (ADBMS)	-	2	1
PC	ICT557	Lab.-4 (ADCC)	-	2	1
PC	ICT567	Soft Computing Lab.	-	2	1
PC	ICT559	Term Paper – 1*			2
Total			**21**	**10**	**28**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Second Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**C**
Theory Papers					
PC	ICT502	Advanced Algorithm Analysis & Design	4		4
PC	ICT504	Advanced Data Warehousing & Data Mining	4		4
PC	ICT506	Computational Optimization	4		4
EA		Emerging Area Elective – 1			4
EA		Emerging Area Elective – 2			4
PC	ICT508	Research Methodology	2		2
Practical/Viva Voce					
PC	ICT552	Lab.-5 (AAAD)	-	2	1
PC	ICT554	Lab.-6 (ADW&DM)	-	2	1
PC	ICT556	Lab.-7 (CO)	-	2	1
PC	ICT558	Term Paper – 2*			2
Total					**27**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Third Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**C**
Theory Papers					
PC	ICT601	Distributed and Cloud Computing	4		4
EA		Emerging Area Elective – 3			4
EA		Emerging Area Elective – 4			4
EA		Emerging Area Elective – 5			4
OA		Open Elective			4
PC	ICT603	Human Values and Ethics*	2		2
Practical/Viva Voce					
PC	ICT651	Lab.-8 (DCC)	-	2	1
PC	ICT653	Major Research Project Part – I**	-	-	4
Total					**27**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

** The research project guideline shall be issued separately by the school with the approval of the Dean, USICT

Fourth Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**C**
Practical/Viva Voce					
PC	ICT652 ICT654	Major Research Project Part – II** Or Internship**	-	-	22
Total					**22**

** The research project and internship guideline shall be issued separately by the school with the approval of the Dean, USICT

Total: 104 Credits

Emerging Areas:

1. **Artificial Intelligence and Machine Learning**
2. **Data Science**
3. **Software Engineering**
4. **Signal and Image Processing**
5. **Cyber Security**
6. **Web Engineering**

In each emerging area a group of papers totalling to 20 credits shall be offered

Open Elective:

1. Advanced Computer Architecture
2. Enterprise Computing using JAVA
3. Web Search and Information Retrieval
4. Introduction to Robotics Engineering
5. Cyber Crime Investigations and Cyber Forensics
6. Natural Language Processing
7. Advanced Multimedia
8. Block Chain Technology
9. Courses offered by other University Schools for the M.Tech Students
10. Courses offered through SWAYAM / NPTEL MOOCs platform

Rules:

By default every student shall do the Major Research Project Part II or an internship. The student must apply to the School for approval to do internship before the commencement of the 4th semester to the school, and only after approval of Dean of the school / Director of Institution / Incharge of the programme of study, through Training and Placement Officer of the School, shall proceed for internship.

The student shall be allocated a supervisor / guide for Term Papers / Major Research Project work at the beginning of respective semesters by the School. The Major Research Project Part - I shall continue into the 4th semester as Major Research Project Part - II for the students not opting for internship. However the M.Tech students shall be encouraged to opt for Major Research Project Part - II.

The students allowed to proceed for internship shall be required to maintain a log-book of activities performed during internship. The same has to be countersigned by the mentor at the organization where internship is completed.

Evaluation shall be conducted of 40 marks (Supervisors' continuous evaluation / internal assessment by a duly constituted committee) for project work and (Industrial Project Leaders' continuous evaluation / internal assessment by a duly constituted committee) for industrial internship. And, 60 marks by an external examiner deputed by examinations division (COE), for a total of 100 marks.

***Note**: In the absence of the supervisor or the Training and placement officer (as the case may be), the Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school.*

Implementation Guidelines:

1. Total Number of Credits: 104
2. Maximum marks for every paper shall be 100.
3. The student shall be allocated a supervisor / guide for Term Papers / Major Research Project work at the beginning of respective semesters by the School. The Major Research Project Part - I shall continue into the 4th semester as Major Research Project Part - II for the students not opting for internship. For major Research Project / Industrial Internship Evaluation shall be conducted of 40 marks (Supervisors' continuous evaluation / internal assessment by a duly constituted committee) for project work and (Industrial Project Leaders' continuous evaluation / internal assessment by a duly constituted committee) for industrial internship. And, 60 marks by an external examiner deputed by examinations division (COE), for a total of 100 marks.
4. For NUES Papers Comprehensive evaluation by a committee of teachers, constituted by the Academic Programme Committee, out of 100.
5. The examinations, attendance criteria to appear in examinations, promotion and award of the degree shall be governed by the Ordinance 11 of the University.
6. Minimum duration of the Master of Technology programme shall be 2 years (N=2 years) (4 semesters).
7. Maximum duration of the Master of Technology programme shall be 4 years (N+2 years).
8. The open electives of the OA group of courses may be taken through SWAYAM / NPTEL MOOCs platform. The student desirous of doing a MOOC based course among the OA group must seek approval of the APC of the school for the same before the commencement of the semester. The APC shall allow the MOOC based OA option to the student if and only if the MOOC subject / course being considered for the student is being offered in line with the Academic Calendar applicable. The student shall submit the successful completion certificate with marks to the School for onwards transfer to the Examination Division. The Examinations Divisions shall take these marks on record for incorporation in the result of the appropriate semester. These courses shall be used for calculation of the SGPA/CGPA of the student concerned by the examination division of the University.
9. These MOOC courses taken by the students, if allowed by the APC of the school shall be of 4 credits or more individually. If the credit of these MOOC Courses, allowed to a student is more than 4, then the maximum credit for the programme shall be amended accordingly for the particular student. Also, in a particular semester, a student may take more than one MOOC course with the approval of the APC to meet the credit requirements of OA for the semester.
10. EA Group courses / papers to be offered to a particular batch, shall be notified by the School at the end of first semester, subject to availability of minimum number of students willing to opt for a paper / group and the availability of faculty offering that paper / group.
11. OA group paper is droppable in the sense that the student may qualify for the award of the degree even when the student has not cleared / passed the paper of this group. However, the student must earn the minimum credits **(100)** for the programme of study as specified.
12. The student must appear for all 104 credits to be considered for the award of the degree.
13. The following degree route can be taken by a student:

    a. The students shall be awarded one minor specialization from EA route under the following conditions:

        i. The student has earned 78 credits from the PC courses /paper.
        ii. The **student has earned 20 credits from the one particular *EA group*courses / papers.**
        iii. In addition, the total credits (including the above specified credits, i.e 98 credits) earned by the student is at least100 credits.

        The degree nomenclature of the degree shall be as: ***"Master of Technology (Primary Discipline) with minor specialization in <concerned EA discipline>)"***;

    b. The students shall be awarded the basic degree under the following conditions:

i. The student has earned 78 credits from the PC courses /paper.
ii. The **student has earned 20 credits from any of the EA courses / papers**
ii. In addition, the total credits (including the above specified credits, i.e. 98 credits) earned by the student is at least 100 credits.

The degree nomenclature of the degree shall be as: "***Master of Technology (Primary Discipline)"***;

14. Pass marks in every paper shall be 40.
15. Grading System shall be as per Ordinance 11 of the University.

Master of Technology in Information Technology
(2 Year Regular Programme)

Programme Educational Objectives for M.Tech (IT) Programme

PEO1: To develop students to critically analyze the problems in the field of information Technology and find optimal solutions.
PEO2: To train students to conduct research and experiments by applying appropriate techniques and tools with an understanding of the limitations for sustainable development of society.
PEO3: To prepare students to act as a member and leader of the team to contribute positively to manage projects efficiently in the field of information Technology.
PEO4: To train the students to effectively communicate, write reports, create documentation and make presentations by adhering to appropriate standards.
PEO5: To stimulate students for life-long learning with enthusiasm and commitment to improve knowledge and competence continuously.

Program Specific Outcomes for M.Tech (IT) Programme (PSO)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems
PO2: An ability to write and present a substantial technical report/document
PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PSO-PEO Matrix*

Filled on a scale of 1 to 3 (3=High; 2=Moderate; 1=Low; '-'for no correlation)

Course Outcomes	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	2	2	2
PO2	3	1	2	3	1
PO3	3	3	3	2	3
PO4	1	2	3	2	2

First Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	ICT501	Advanced Data Structures	4		4
PC	ICT513	Wireless Sensor Networks	4		4
PC	ICT505	Soft Computing	3		3
PC	ICT507	Advanced DBMS	4		4
PC	ICT509	Advances in Data & Computer Communications	4		4
PC	ICT511	Scientific Writing		2	2
Practical/Viva Voce					
PC	ICT551	Lab.-1 (ADS)	-	2	1
PC	ICT561	Lab.-2 (WSN)	-	2	1
PC	ICT555	Lab.-3 (ADBMS)	-	2	1
PC	ICT557	Lab.-4 (ADCC)	-	2	1
PC	ICT567	Soft Computing Lab.	-	2	1
PC	ICT559	Term Paper – 1*			2
Total			**21**	**10**	**28**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Second Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	ICT502	Advanced Algorithm Analysis & Design	4		4
PC	ICT510	Advanced Signal Processing	4		4
PC	ICT512	Information Theory and Coding	4		4
EA		Emerging Area Elective – 1			4
EA		Emerging Area Elective – 2			4
PC	ICT508	Research Methodology	2		2
Practical/Viva Voce					
PC	ICT552	Lab.-5 (AAAD)	-	2	1
PC	ICT560	Lab.-6 (ASP)	-	2	1
PC	ICT562	Lab.-7 (ITC)	-	2	1
PC	ICT558	Term Paper – 2*			2
Total					**27**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Third Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	ICT601	Distributed and Cloud Computing	4		4
EA		Emerging Area Elective – 3			4
EA		Emerging Area Elective – 4			4
EA		Emerging Area Elective – 5			4
OA		Open Elective			4
PC	ICT603	Human Values and Ethics*	2		2
Practical/Viva Voce					
PC	ICT651	Lab.-8 (DCC)	-	2	1
PC	ICT653	Major Research Project Part – I**	-	-	4
Total					**27**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

** The research project guideline shall be issued separately by the school with the approval of the Dean, USICT

Fourth Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Practical/Viva Voce					
PC	ICT652 ICT654	Major Research Project Part – II** Or Internship**	-	-	22
Total					**22**

** The research project and internship guidelines shall be issued separately by the school with the approval of the Dean, USICT

Total: 104 Credits

Emerging Areas:

1. **Artificial Intelligence and Machine Learning**
2. **Data Science**
3. **Software Engineering**
4. **Signal and Image Processing**
5. **Cyber Security**
6. **Web Engineering**
7. **Internet of Things**
8. **Mobile and Wireless Communication**
9. **Robotics and Automation**

In each emerging area a group of papers totalling to 20 credits shall be offered

Open Elective:

1. Advanced Computer Architecture
2. Enterprise Computing using JAVA
3. Web Search and Information Retrieval
4. Introduction to Robotics Engineering
5. Computer Forensics and Investigation
6. Natural Language Processing
7. Parallel Algorithms
8. Advanced Multimedia
9. Block Chain Technology
10. Multimedia Communication
11. Courses offered by other University Schools for the M.Tech Students
12. Courses offered through SWAYAM / NPTEL MOOCs platform

Rules:

By default every student shall do the Major Research Project Part II or an internship. The student must apply to the School for approval to do internship before the commencement of the 4th semester to the school, and only after approval of Dean of the school / Director of Institution / Incharge of the programme of study, through Training and Placement Officer of the School, shall proceed for internship.

The student shall be allocated a supervisor / guide for Term Papers / Major Research Project work at the beginning of respective semesters by the School. The Major Research Project Part - I shall continue into the 4th semester as Major Research Project Part - II for the students not opting for internship. However the M.Tech students shall be encouraged to opt for Major Research Project Part - II.

The students allowed to proceed for internship shall be required to maintain a log-book of activities performed during internship. The same has to be countersigned by the mentor at the organization where internship is completed.

Evaluation shall be conducted of 40 marks (Supervisors' continuous evaluation / internal assessment by a duly constituted committee) for project work and (Industrial Project Leaders' continuous evaluation / internal assessment by a duly constituted committee) for industrial internship. And, 60 marks by an external examiner deputed by examinations division (COE), for a total of 100 marks.

***Note**: In the absence of the supervisor or the Training and placement officer (as the case may be), the Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school.*

Implementation Guidelines:

1. Total Number of Credits: 104
2. Maximum marks for every paper shall be 100.
3. The student shall be allocated a supervisor / guide for Term Papers / Major Research Project work at the beginning of respective semesters by the School. The Major Research Project Part - I shall continue into the 4th semester as Major Research Project Part - II for the students not opting for internship. For major Research Project / Industrial Internship Evaluation shall be conducted of 40 marks (Supervisors' continuous evaluation / internal assessment by a duly constituted committee) for project work and (Industrial Project Leaders' continuous evaluation / internal assessment by a duly constituted committee) for industrial internship. And, 60 marks by an external examiner deputed by examinations division (COE), for a total of 100 marks.
4. For NUES Papers Comprehensive evaluation by a committee of teachers, constituted by the Academic Programme Committee, out of 100.
5. The examinations, attendance criteria to appear in examinations, promotion and award of the degree shall be governed by the Ordinance 11 of the University.
6. Minimum duration of the Master of Technology programme shall be 2 years (N=2 years) (4 semesters).
7. Maximum duration of the Master of Technology programme shall be 4 years (N+2 years).
8. The open electives of the OA group of courses may be taken through SWAYAM / NPTEL MOOCs platform. The student desirous of doing a MOOC based course among the OA group must seek approval of the APC of the school for the same before the commencement of the semester. The APC shall allow the MOOC based OA option to the student if and only if the MOOC subject / course being considered for the student is being offered in line with the Academic Calendar applicable. The student shall submit the successful completion certificate with marks to the School for onwards transfer to the Examination Division. The Examinations Divisions shall take these marks on record for incorporation in the result of the appropriate semester. These courses shall be used for calculation of the SGPA/CGPA of the student concerned by the examination division of the University.
9. These MOOC courses taken by the students, if allowed by the APC of the school shall be of 4 credits or more individually. If the credit of these MOOC Courses, allowed to a student is more than 4, then the maximum credit for the programme shall be amended accordingly for the particular student. Also, in a particular semester, a student may take more than one MOOC course with the approval of the APC to meet the credit requirements of OA for the semester.
10. EA Group courses / papers to be offered to a particular batch, shall be notified by the School at the end of first semester, subject to availability of minimum number of students willing to opt for a paper / group and the availability of faculty offering that paper / group.
11. OA group paper is droppable in the sense that the student may qualify for the award of the degree even when the student has not cleared / passed the paper of this group. However, the student must earn the minimum credits **(100)** for the programme of study as specified.
12. The student must appear for all 104 credits to be considered for the award of the degree.
13. The following degree route can be taken by a student:

    a. The students shall be awarded one minor specialization from EA route under the following conditions:

        i. The student has earned 78 credits from the PC courses /paper.
        ii. The **student has earned 20 credits from the one particular *EA group*courses / papers.**
        iii. In addition, the total credits (including the above specified credits, i.e 98 credits) earned by the student is at least100 credits.

        The degree nomenclature of the degree shall be as: "***Master of Technology (Primary Discipline) with minor specialization in <concerned EA discipline>)***";

    b. The students shall be awarded the basic degree under the following conditions:

i. The student has earned 78 credits from the PC courses /paper.
ii. The **student has earned 20 credits from any of the EA courses / papers**
ii. In addition, the total credits (including the above specified credits, i.e. 98 credits) earned by the student is at least 100 credits.

The degree nomenclature of the degree shall be as: "***Master of Technology (Primary Discipline)"***;

14. Pass marks in every paper shall be 40.
15. Grading System shall be as per Ordinance 11 of the University.

Master of Technology in Electronics and Communications Engineering
(2 Year Regular Programme)

Programme Educational Objectives for M.Tech (ECE) Programme

PEO1: To develop students to critically analyze the problems in the field of electronics and communications engineering and find optimal solutions.
PEO2: To train students to conduct research and experiments by applying appropriate techniques and tools with an understanding of the limitations for sustainable development of society.
PEO3: To prepare students to act as a member and leader of the team to contribute positively to manage projects efficiently in the field of electronics and communications engineerin.
PEO4: To train the students to effectively communicate, write reports, create documentation and make presentations by adhering to appropriate standards.
PEO5: To stimulate students for life-long learning with enthusiasm and commitment to improve knowledge and competence continuously.

Program Outcomes for M.Tech (ECE) Programme(PSO)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems
PO2: An ability to write and present a substantial technical report/document
PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PSO-PEO Matrix*

Filled on a scale of 1 to 3 (3=High; 2=Moderate; 1=Low; '-'for no correlation)

Course Outcomes	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	2	2	2
PO2	3	1	2	3	1
PO3	3	3	3	2	3
PO4	1	2	3	2	2

First Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	ICT515	Analog Integrated Circuit Design	4		4
PC	ICT513	Wireless and Sensor Networks	4		4
PC	ICT505	Soft Computing	3		3
PC	ICT517	Advanced Electromagnetics	4		4
PC	ICT509	Advances in Data & Computer Communications	4		4
PC	ICT511	Scientific Writing	2		2
Practical/Viva Voce					
PC	ICT563	Lab.-1 (AICD)	-	2	1
PC	ICT561	Lab.-2(WSN)	-	2	1
PC	ICT565	Lab.-3 (AE)	-	2	1
PC	ICT557	Lab.-4 (ADCC)	-	2	1
PC	ICT567	Soft Computing Lab.	-	2	1
PC	ICT559	Term Paper – 1*			2
Total			**21**	**10**	**28**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Second Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	ICT512	Digital Integrated Circuit Design	4		4
PC	ICT510	Advanced Signal Processing	4		4
PC	ICT512	Information Theory and Coding	4		4
EA		Emerging Area Elective – 1			4
EA		Emerging Area Elective – 2			4
PC	ICT508	Research Methodology	2		2
Practical/Viva Voce					
PC	ICT664	Lab.-5 (DICD)	-	2	1
PC	ICT560	Lab.-6 (ASP)	-	2	1
PC	ICT562	Lab.-7 (ITC)	-	2	1
PC	ICT558	Term Paper – 2*			2
Total			**14**	**6**	**27**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Third Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	ICT605	Advanced Communication Systems	4		4
EA		Emerging Area Elective – 3			4
EA		Emerging Area Elective – 4			4
EA		Emerging Area Elective – 5			4
OA		Open Elective			4
PC	ICT603	Human Values and Ethics*			2
Practical/Viva Voce					
PC	ICT655	Lab.-8 (ACS)	-	2	1
PC	ICT653	Major Research Project Part – I**	-	-	4
Total					**27**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

** The research project guideline shall be issued separately by the school with the approval of the Dean, USICT

Fourth Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Practical/Viva Voce					
PC	ICT652 ICT654	Major Research Project Part – II** Or Internship**	-	-	22
Total					**22**

** The research project and internship guideline shall be issued separately by the school with the approval of the Dean, USICT

Total: 104 Credits

Emerging Areas:

1. **Artificial Intelligence and Machine Learning**
2. **Signal and Image Processing**
3. **Internet of Things**
4. **Cyber Security**
5. **Mobile and Wireless Communication**
6. **Robotics and Automation**
7. **VLSI Design and Embedded Systems**
8. **Communication Engineering**

In each emerging area a group of papers totalling to 20 credits shall be offered

Open Elective:

1. Advanced Computer Architecture
2. Introduction to Robotics Engineering
3. Computer Forensics and Investigation
4. Microwave Integrated Circuits
5. ESD using ARM Microcontroller
6. Semiconductor Optoelectronics
7. Courses offered by other University Schools for the M.Tech Students
8. Courses offered through SWAYAM / NPTEL MOOCs platform

Rules:

By default every student shall do the Major Research Project Part II or an internship. The student must apply to the School for approval to do internship before the commencement of the 4^{th} semester to the school, and only after approval of Dean of the school / Director of Institution / Incharge of the programme of study, through Training and Placement Officer of the School, shall proceed for internship.

The student shall be allocated a supervisor / guide for Term Papers / Major Research Project work at the beginning of respective semesters by the School. The Major Research Project Part - I shall continue into the 4^{th} semester as Major Research Project Part - II for the students not opting for internship. However the M.Tech students shall be encouraged to opt for Major Research Project Part - II.

The students allowed to proceed for internship shall be required to maintain a log-book of activities performed during internship. The same has to be countersigned by the mentor at the organization where internship is completed.

Evaluation shall be conducted of 40 marks (Supervisors' continuous evaluation / internal assessment by a duly constituted committee) for project work and (Industrial Project Leaders' continuous evaluation / internal assessment by a duly constituted committee) for industrial internship. And, 60 marks by an external examiner deputed by examinations division (COE), for a total of 100 marks.

***Note**: In the absence of the supervisor or the Training and placement officer (as the case may be), the Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school.*

Implementation Guidelines:

1. Total Number of Credits: 104
2. Maximum marks for every paper shall be 100.
3. The student shall be allocated a supervisor / guide for Term Papers / Major Research Project work at the beginning of respective semesters by the School. The Major Research Project Part - I shall continue into the 4th semester as Major Research Project Part - II for the students not opting for internship. For major Research Project / Industrial Internship Evaluation shall be conducted of 40 marks (Supervisors' continuous evaluation / internal assessment by a duly constituted committee) for project work and (Industrial Project Leaders' continuous evaluation / internal assessment by a duly constituted committee) for industrial internship. And, 60 marks by an external examiner deputed by examinations division (COE), for a total of 100 marks.
4. For NUES Papers Comprehensive evaluation by a committee of teachers, constituted by the Academic Programme Committee, out of 100.
5. The examinations, attendance criteria to appear in examinations, promotion and award of the degree shall be governed by the Ordinance 11 of the University.
6. Minimum duration of the Master of Technology programme shall be 2 years (N=2 years) (4 semesters).
7. Maximum duration of the Master of Technology programme shall be 4 years (N+2 years).
8. The open electives of the OA group of courses may be taken through SWAYAM / NPTEL MOOCs platform. The student desirous of doing a MOOC based course among the OA group must seek approval of the APC of the school for the same before the commencement of the semester. The APC shall allow the MOOC based OA option to the student if and only if the MOOC subject / course being considered for the student is being offered in line with the Academic Calendar applicable. The student shall submit the successful completion certificate with marks to the School for onwards transfer to the Examination Division. The Examinations Divisions shall take these marks on record for incorporation in the result of the appropriate semester. These courses shall be used for calculation of the SGPA/CGPA of the student concerned by the examination division of the University.
9. These MOOC courses taken by the students, if allowed by the APC of the school shall be of 4 credits or more individually. If the credit of these MOOC Courses, allowed to a student is more than 4, then the maximum credit for the programme shall be amended accordingly for the particular student. Also, in a particular semester, a student may take more than one MOOC course with the approval of the APC to meet the credit requirements of OA for the semester.
10. EA Group courses / papers to be offered to a particular batch, shall be notified by the School at the end of first semester, subject to availability of minimum number of students willing to opt for a paper / group and the availability of faculty offering that paper / group.
11. OA group paper is droppable in the sense that the student may qualify for the award of the degree even when the student has not cleared / passed the paper of this group. However, the student must earn the minimum credits **(100)** for the programme of study as specified.
12. The student must appear for all 104 credits to be considered for the award of the degree.
13. The following degree route can be taken by a student:

    a. The students shall be awarded one minor specialization from EA route under the following conditions:

        i. The student has earned 78 credits from the PC courses /paper.
        ii. The **student has earned 20 credits from the one particular *EA group*courses / papers.**
        iii. In addition, the total credits (including the above specified credits, i.e 98 credits) earned by the student is at least100 credits.

        The degree nomenclature of the degree shall be as: ***"Master of Technology (Primary Discipline) with minor specialization in <concerned EA discipline>)"***;

    b. The students shall be awarded the basic degree under the following conditions:

i. The student has earned 78 credits from the PC courses /paper.
ii. The **student has earned 20 credits from any of the EA courses / papers**
ii. In addition, the total credits (including the above specified credits, i.e. 98 credits) earned by the student is at least 100 credits.

The degree nomenclature of the degree shall be as: "***Master of Technology (Primary Discipline)"***;

14. Pass marks in every paper shall be 40.
15. Grading System shall be as per Ordinance 11 of the University.

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Master of Technology in Robotics and Automation
(2 Year Regular Programme)

Programme Educational Objectives for M.Tech (Robotics and Automation) Programme

PEO1: To develop students to critically analyze the problems in the field of Robotics and Automation and find optimal solutions.
PEO2: To train students to conduct research and experiments by applying appropriate techniques and tools with an understanding of the limitations for sustainable development of society.
PEO3: To prepare students to act as a member and leader of the team to contribute positively to manage projects efficiently in the field of Robotics and Automation.
PEO4: To train the students to effectively communicate, write reports, create documentation and make presentations by adhering to appropriate standards.
PEO5: To stimulate students for life-long learning with enthusiasm and commitment to improve knowledge and competence continuously.

Program Specific Outcomes for M.Tech (Robotics and Automation) Programme (PSO)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems
PO2: An ability to write and present a substantial technical report/document
PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PSO-PEO Matrix*
Filled on a scale of 1 to 3 (3=High; 2=Moderate; 1=Low; '-'for no correlation)

Program Specific Outcomes	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	2	2	2
PO2	3	1	2	3	1
PO3	3	3	3	2	3
PO4	1	2	3	2	2

M.Tech (Robotics & Automation)

First Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	RA501	Computational Techniques using MATLAB	4		4
PC	RA503	Robotics Engineering	4		4
PC	RA505	Mechatronics Systems and Applications	4		4
PC	RA507 RA509	Introduction to Manufacturing Systems *(For CSE/IT/ECE/ICE background students)* or Introduction to Electrical and Electronics Systems *(For MAE/Mechanical/Production/Industrial Engineering background students)*	4		4
PC	RA513	Control Systems and Applications	4		4
HS	ICT511	Scientific Writing	2		2
Practical/Viva Voce					
PC	RA551	Lab.-1 (Computational Techniques Lab)	-	2	1
PC	RA553	Lab.-2 (Robotics Engineering Lab)	-	2	1
PC	RA555	Lab.-3 (Mechatronics Lab)	-	2	1
PC	RA557	Lab.-4 (Control System lab)	-	2	1
PC	ICT559	Term Paper – 1*			2
Total			**22**	**8**	**28**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Second Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	RA502	Mobile Robots	4		4
PC	RA504	CAD/CAM	4		4
PC	RA506	Artificial Intelligence in Automation	4		4
EA	RA512	Embedded systems and Internet of Things	4		4
EA	RA510	Image Processing and Computer Vision	4		4
PC	ICT508	Research Methodology	2		2
Practical/Viva Voce					
PC	RA552	Lab.-5 (CAD/CAM Lab)	-	2	1
PC	RA554	Lab.-6 (AI lab)	-	2	1
PC	RA556	Lab.-7 (Image Processing and Computer Vision Lab)	-	2	1
PC	ICT558	Term Paper – 2*			2
Total			**22**	**6**	**27**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Third Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	RA601	Computer Integrated Manufacturing	4		4
PC	RA603	Rapid Prototyping	4		4
PE		**Elective I (Choose any one)**	4		4
	RA605	Optimization methods in Engineering			
	RA607	Design of Mechanisms and Manipulators			
	RA609	Human Robot Interaction			
	RA611	Vehicle dynamics and multibody systems			
PE		**Elective-II (Choose any ONE)**	4		4
	RA613	Soft Computing			
	RA615	Machine Learning			
	RA617	Simulation and Modelling			
	RA619	Micro and Nano Electrical-mechanical systems (MEMS & NEMS)			
OE		**Open Elective (Choose any ONE)**	4		4
	RA621	Product Design and Development			
	RA621	Operation Research			
	RA623	Intellectual Property Rights			
	RA625	Enterprise resource planning			
		Courses offered by other University Schools for the M.Tech Students			
		Courses offered through SWAYAM / NPTEL MOOCs platform			
PC	ICT603	Human Values and Ethics*	2		2
Practical/Viva Voce					
PC	RA651	Lab.-8 (Rapid Prototype Lab)	-	2	1
PC	ICT653	Major Research Project Part – I**	-	-	4
Total			**22**	**2**	**27**

** The research project and internship guideline shall be issued separately by the school with the approval of the Dean, USICT

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Fourth Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Practical/Viva Voce					
PC	ICT652 ICT654	Major Research Project Part – II** Or Internship**	-	-	22
Total					**22**

** The research project and internship guideline shall be issued separately by the school with the approval of the Dean, USICT

Total: 104 Credits

NOTE:

1. The total number of credits of the Programme M. Tech. = 108.
2. Each student shall be required to appear for examination in all courses, But for the award of the degree a student shall be required to earn the minimum of 100 credits out of 108. However only Elective Courses and Term papers may be dropped towards counting for total credits of 100 to award M. Tech. Degree.

Rules:

By default every student shall do the Major Research Project Part II or an internship. The student must apply to the School for approval to do internship before the commencement of the 4th semester to the school, and only after approval of Dean of the school / Director of Institution / Incharge of the programme of study, through Training and Placement Officer of the School, shall proceed for internship.

The student shall be allocated a supervisor / guide for Term Papers / Major Research Project work at the beginning of respective semesters by the School. The Major Research Project Part - I shall continue into the 4th semester as Major Research Project Part - II for the students not opting for internship. However the M.Tech students shall be encouraged to opt for Major Research Project Part - II.

The students allowed to proceed for internship shall be required to maintain a log-book of activities performed during internship. The same has to be countersigned by the mentor at the organization where internship is completed.

Evaluation shall be conducted of 40 marks (Supervisors' continuous evaluation / internal assessment by a duly constituted committee) for project work and (Industrial Project Leaders' continuous evaluation / internal assessment by a duly constituted committee) for industrial internship. And, 60 marks by an external examiner deputed by examinations division (COE), for a total of 100 marks.

***Note**: In the absence of the supervisor or the Training and placement officer (as the case may be), the Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school.*

Implementation Guidelines:

1. Total Number of Credits: 104
2. Maximum marks for every paper shall be 100.
3. The student shall be allocated a supervisor / guide for Term Papers / Major Research Project work at the beginning of respective semesters by the School. The Major Research Project Part - I shall continue into the 4th semester as Major Research Project Part - II for the students not opting for internship. For major Research Project / Industrial Internship Evaluation shall be conducted of 40 marks (Supervisors' continuous evaluation / internal assessment by a duly constituted committee) for project work and (Industrial Project Leaders' continuous evaluation / internal assessment by a duly constituted committee) for industrial internship.And, 60 marks by an external examiner deputed by examinations division (COE), for a total of 100 marks.
4. For NUES Papers Comprehensive evaluation by a committee of teachers, constituted by the Academic Programme Committee, out of 100.
5. The examinations, attendance criteria to appear in examinations, promotion and award of the degree shall be governed by the Ordinance 11 of the University.
6. Minimum duration of the Master of Technology programme shall be 2 years (N=2 years) (4 semesters).
7. Maximum duration of the Master of Technology programme shall be 4 years (N+2 years).
8. The open electives of the OA group of courses may be taken through SWAYAM / NPTEL MOOCs platform. The student desirous of doing a MOOC based course among the OA group must seek approval of the APC of the school for the same before the commencement of the semester. The APC shall allow the MOOC based OA option to the student if and only if the MOOC subject / course being considered for the student is being offered in line with the Academic Calendar applicable. The student shall submit the successful completion certificate with marks to the School for onwards transfer to the Examination Division. The Examinations Divisions shall take these marks on record for incorporation in the result of the appropriate semester. These courses shall be used for calculation of the SGPA/CGPA of the student concerned by the examination division of the University.
9. These MOOC courses taken by the students, if allowed by the APC of the school shall be of 4 credits or more individually. If the credit of these MOOC Courses, allowed to a student is more than 4, then the maximum credit for the programme shall be amended accordingly for the particular student. Also, in a particular semester, a student may take more than one MOOC course with the approval of the APC to meet the credit requirements of OA for the semester.
10. EA Group courses / papers to be offered to a particular batch, shall be notified by the School at the end of first semester, subject to availability of minimum number of students willing to opt for a paper / group and the availability of faculty offering that paper / group.
11. OA group paper is droppable in the sense that the student may qualify for the award of the degree even when the student has not cleared / passed the paper of this group. However, the student must earn the minimum credits **(100)**for the programme of study as specified.
12. The student must appear for all 104 credits to be considered for the award of the degree.
13. The degree shall be conferred to the student if and only if the student satisfies the following:
    a. The students has appeared in all the papers offered (at least 104 credits)
    b. The student has acquired at least 100 credits from all the papers (other than the open elective).
14. Pass marks in every paper shall be 40.
15. Grading System shall be as per Ordinance 11 of the University.

Detailed Syllabus of 1st Semester Papers

Paper ID:		**L**	**T**	**C**
Code: ICT 501	**Paper: Advanced Data Structures**	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS:

Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks

Course Outcome:

CO 1	Ability to understand the concept and implement Sparse Matrices, AVL, Red Black trees Heap etc.
CO 2	Learn implementation and application of Data Structures for Disjoint sets used in Graph Algorithms
CO 3	Understand concept and requirement of external searching and sorting
CO 4	Understand concept and requirement of external searching and sorting

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	3	-	3	2
CO 2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	2

UNIT - I

Elementary Data Structure: Arrays , Sparse Matrices , strings , stack, queues ,Evaluation of Expressions , Linked list , Polynomials : Representation and Operations binary Trees and operations , Binary search tress : Operation and Characteristics

UNIT - II

Binary Heaps, Fibonacci Heaps, Amortized analysis of Data structures, Balanced Search Trees, AVL trees, augmented data structure, Red Black Trees and properties

UNIT - III

Graph representation and implementation, searching of a graph, application of BFS and DFS Data structure for Sets, Disjoint Set and Union – find problem and implementation, Basic Hash function and collision resolution Hash Tables (Universal Hashing, Perfect Hashing) implementation and Applications

UNIT - IV

External sorting, Multiway search trees , B and B + Trees implementation, Digital Search Trees , Multiway Tries, Suffix Trees and applications.

Textbook(s):

1. T. H. Cormen, C. E. Leiserson, R.L. Rivest, C. Stein, “Introduction to Algorithms”, 3rd Edition, PHI, 2009
2. Ellis Horowitz, Sartaj Sahni & Anderson-Freed, “Fundamentals of Data Structures ”, 2nd Edition, Universities Press,2008

References:

1.Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, 2nd Edition, Pearson Education India,1996.
2.Robert L. Kruse, Bruce P. Leung, “Data Structures and Program Design in C”, 2nd Edition, Pearson Education, 2006
3.M. Goodrich, R. Tamassia, and D. Mount, “Data Structures and Algorithms in C++” , 2nd Edition, Wiley,2014

Paper ID:		**L**	**T**	**C**
Code: ICT503	**Paper: Advanced Software Engineering**	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS:

Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks

Course Outcome:

CO 1	Understand classical and agile software process models.
CO 2	To analyse requirements, design, develop and maintain software systems.
CO 3	Understand size and cost estimation of software projects.
CO 4	To develop and execute test cases for software systems using different testing techniques.

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	3	-	3	-
CO 2	3	3	3	3
CO3	3	-	3	-
CO4	3	-	3	3

UNIT - I

Software Process Models: Software Process, Generic Process Model – Framework Activity, Task Set and Process Patterns; Process Lifecycle, Prescriptive Process Models –Waterfall, incremental, Evolutionary concurrent models, Rational Unified Process.

Agile Process Models – Extreme Programming (XP), Adaptive Software Development, Scrum, Dynamic System Development Model, Feature Driven Development, Crystal.

UNIT - II

Software Requirements: Functional and Non-Functional Requirements; Eliciting Requirements, Developing Use Cases, Requirement Analysis and Modelling; Requirements Review, Software Requirement and Specification (SRS) Document.

Estimation and Scheduling of Software Projects: Software Sizing, LOC and FP based Estimations; Estimating Cost and Effort; Estimation Models, Constructive Cost Model (COCOMO), Project Scheduling and Staffing; Time-line Charts.

UNIT - III

Software Design: Abstraction, Architecture, Patterns, Separation of Concerns, Modularity, Information Hiding, Functional Independence, Cohesion and Coupling; Object-Oriented Design, Data Design, Architectural Design, User Interface Design, Component Level Design.

Software Quality: McCall's Quality Factors, ISO 9126 Quality Factors, Quality Control, Quality Assurance, Risk Management, Risk Mitigation, Monitoring and Management (RMMM).

Software Reliability: Importance, Hardware Reliability & Software Reliability, Failure and Faults, Reliability Models, Basic Model, Logarithmic Poisson Model, Calendar time Component.

UNIT - IV

Software Testing: Testing process, Design of test cases, functional testing, Structural testing, Path Testing, Data flow and mutation testing, Unit Testing, Integration and System Testing, Debugging, Alpha & Beta Testing, Regression Testing, Testing Tools & Standards.

Software Maintenance: Management of Maintenance, Maintenance Process, Maintenance Models, Reverse Engineering, Software Re-engineering, Configuration Management, Documentation.

Software Metrics: Software measurements, Design Metrics, Data Structure Metrics, Information Flow Metrics, Object-Oriented Metrics, MOOD Metrics.

Textbook(s):

1. Roger S. Pressman, "Software Engineering- A Practitioner's Approach", Eighth Edition, McGraw-Hill International Edition, 2010.

2. K.K. Aggarwal & Yogesh Singh, "Software Engineering", New Age International Publishers, New Delhi, Third Edition, 2008.

References:

1. Pankaj Jalote,"A Concise Introduction to Software Engineering", Springer, 2008.
2. Ian Sommerville, "Software Engineering", 10th edition, Pearson, 2018.
3.Stephan Scach, "Software Engineering", McGraw Hill, 2008

Paper ID:		**L**	**T**	**C**
Code: ICT 505	**Paper: Soft Computing**	**3**	**0**	**3**

INSTRUCTIONS TO PAPER SETTERS:

Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks

Course Outcome:

CO 1	Understand soft computing techniques like Neural Networks and their role in problem solving.
CO 2	Conceptualize and parameterize various problems to be solved through basic soft computing techniques in Fuzzy systems
CO 3	Analyze and integrate various Evolutionary algorithms in order to solve problems effectively and efficiently.
CO 4	Understand use of Rough sets and Hybrid Systems in problem solving

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	3	1	3	2
CO 2	3	1	3	2
CO3	3	2	3	2
CO4	3	2	3	1

UNIT – I

Introduction: Introduction to Soft Computing Concepts, Importance of tolerance in imprecision and uncertainty, Soft Computing Constituents and Conventional Artificial Intelligence, From Conventional AI to Computational Intelligence, Fuzzy Set Theory, Neural Networks and Evolutionary Computation

Neural Networks: Overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.

UNIT – II

Introduction to Fuzzy Sets: Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations.

Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges.

Uncertainty based Information: Information & Uncertainty, Nonspecificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets, Defuzzyfication.

UNIT – III

Evolutionary Computation: Genetic Algorithms and Genetic Programming, Evolutionary Programming, Evolutionary Strategies and Differential Evolution Coevolution, Different operators of Genetic Algorithms, Analysis of Selection Operations, Convergence of Genetic Algorithms

UNIT – IV

Rough Sets: Introduction, Imprecise categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications.

Hybrid Systems: Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks.Fuzzy Logic bases Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications.

Textbook(s) / Reference(s):

1. Anderson J.A, "An Introduction to Neural Networks",PHI, 1999.
2. Hertz J. Krogh, R.G. Palmer, "Introduction to the Theory of Neural Computation", Addison-Wesley, California, 1991.
3.Neural Networks-A Comprehensive Foundations", Prentice-Hall International, New Jersey,1999.
4.Freeman J.A. & D.M. Skapura. "Neural Networks: Algorithms, Applications and Programming Techniques", Addison Wesley, Reading, Mass, 1992.
5.G.J. Klir& B. Yuan, "Fuzzy Sets & Fuzzy Logic", PHI, 1995.
6.Melanie Mitchell, "An Introduction to Genetic Algorithm", PHI, 1998.

Paper ID:	**L**	**T**	**C**
Code: ICT507 Paper: Advanced Database Management System	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS:

Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks

Course Outcomes:

CO 1	To review the basics of database management system along with database design and query languages
CO 2	To introduce to the students the concepts of query processing and optimization and transaction processing
CO 3	To introduce to the students the concepts of distributed databases, client server databases, object oriented and object relational databases
CO 4	To introduce to the students to data warehousing, data mining, multimedia and web databases

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	1	1	3	2
CO 2	2	1	3	2
CO3	3	2	3	2
CO4	3	2	3	2

UNIT - I

Relational Databases: Integrity Constraints revisited, Extended ER diagram, Relational Algebra & Calculus, Functional, Muiltivalued and Join Dependency, Normal Forms, Rules about functional dependencies.

Active Database and Real Time Databases: Triggers in SQL, Event Constraint and Action: ECA Rules, Query Processing and Concurrency Control, Compensation and Databases Recovery

UNIT - II

Deductive Databases : Datalog and Recursion, Evaluation of Datalog program, Recursive queries with negation.

Objected Oriented and Object Relational Databases: Modeling Complex Data Semantics, Specialization, Generalization, Aggregation and Association, Objects, Object Identity, Equality and Object Reference, Architecture of Object Oriented and Object Relational Databases

Parallel and Distributed Databases: Distributed Data Storage – Fragmentation & Replication, Location and Fragment Transparency Distributed Query Processing and Optimization, Distributed Transaction Modeling and concurrency Control, Distributed Deadlock, Commit Protocols, Design of Parallel Databases, Parallel Query Evaluation

UNIT - III

Query Processing and Optimization: Valuation of Relational Operations, Transformation of Relational Expressions, Indexing and Query Optimization, Limitations of Relational Data Model, Null Values and Partial Information.

Advanced Transaction Processing: Nested and Multilevel Transactions, Compensating Transactions and Saga, Long Duration Transactions, Weak Levels of Consistency, Transaction Work Flows, Transaction Processing Monitors.

Image and Multimedia Databases: Modeling and Storage of Image and Multimedia Data, Data Structures – R-tree, k-d tree, Quad trees, Content Based Retrieval: Color Histograms, Textures, etc., Image Features, Spatial and Topological Relationships, Multimedia Data Formats, Video Data Model, Audio & Handwritten Data, Geographic Information Systems (GIS)

UNIT - IV

WEB Database: Accessing Databases through WEB, WEB Servers, XML Databases, Commercial Systems.

Data Warehousing: Data Warehousing Architecture, Multidimensional Data Model, Update Propagation OLAP Queries.

Data Mining: Knowledge Representation Using Rules, Association and Classification Rules, Sequential Patterns, Algorithms for Rule Discovery
Case Study: Oracle Xi

Textbook(s):

1.Elmarsi, Navathe, Somayajulu, Gupta, "Fundamentals of Database Systems", 4th Edition, Pearson Education, 2007
2.Garcia, Ullman, Widom, "Database Systems, The complete book", Pearson Education, 2007
3.R. Ramakrishnan, "Database Management Systems", McGraw Hill International Editions, 1998

References:

1.Date, Kannan, Swaminathan, "An Introduction to Database Systems", 8th Edition Pearson Education, 2007
2.Singh S.K., "Database System Concepts, design and application", Pearson Education, 2006.
3.Silberscatz, Korth, Sudarshan, "Database System Concepts", Mcgraw Hill, 6th Edition, 2006
4.D. Maier, "The Theory of Relational Databases", Computer Science Press, Rokville, Maryland, 1993.
5.Ullman, J. D., "Principals of database systems", Galgotia publications, 1999
6. Oracle Xi Reference Manual

Paper ID:		**L**	**T**	**C**
Code: ICT509	**Paper: Advances in Data & Computer Communications**	**4**	**0**	**4**

Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks

Course Outcome:

CO 1	To understand basics of layered architectures(OSI & TCP/IP) , and its applications.
CO 2	To understand network layer algorithms and protocols with WAN technology.
CO 3	Study of transport layer protocols and client-server protocols.
CO 4	To introduce the student to the major concepts related to internet security and internet multimedia protocols.

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	3	-	3	-
CO 2	3	-	3	-
CO3	3	-	3	-
CO4	3	-	3	-

UNIT-I

Data Communications and networking, Protocol Architecture (OSI and TCP/IP), Network performance issues and concepts,

LAN Standards: Ethernet (IEEE 802.3), Wireless LAN standard (IEEE 802.11),High Speed LANs, Gigabit Wi-Fi

UNIT-II

Internet Protocol Operation, ARP and RARP, Class full and Classless IP Addresses, IPv6, Router basics: Types, configuration & operation, RIP, OSPF and BGP, congestion control in Switched data networks

WAN Technology & Protocols

UNIT-III

Transport layer protocols(TCP & UDP) and Stream Controlled Transmission Protocol (SCTP)

Client –server protocols: WWW , HTTP, FTP ,E-mail, Telnet, DNS

UNIT-IV

Network layer Security: IPsec, VPN, Transport Layer Security, Firewalls

Voice & Video Services on Packet based network: VoIP, Skype and P2P network, SIP, IPTV: Video on Demand(VoD)

Textbook(s):

1.Stallings W., “Data and Computer Communications”, 10th Ed., Pearson Education, 2017

2.Behrouz A. Forouzan, “Data Communications and Networking”, McGraw Hill Education,5th Ed, 2017

References:

1.Tananbaum A. S., “Computer Networks”, 5th Ed., Pearson Education India, 2013

2.Wayne Tomasi, “Introduction to Data communications and Networking”, Pearson Ed. 2007

3.Black U, “Computer Networks-Protocols, Standards and Interfaces”, PHI, 1996

Paper ID:	**L**	**T**	**C**
Code: ICT511 Paper: Scientific Writing	**2**	**-**	**2**
The evaluation shall be conducted by the concerned teacher (NUES)			

Course Outcome:

CO 1	To understand the structure of a scientific paper or document
CO 2	To understand the criterion of evaluation of manuscript by a reviewer
CO 3	Study of transport layer protocols and client-server protocols.
CO 4	To introduce the student to the major concepts related to internet security and internet multimedia protocols.

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	-	3	-	3
CO 2	-	3	-	3
CO3	-	3	-	3
CO4	-	3	-	3

UNIT-I
Why write a scientific manuscript. Structure of a manuscript: Abstract, Introduction, Materials and Methods, Results, and Discussions and its variations. Language.

UNIT-II
Learning to use latex as a text formatting tool. Book, article, report and presentation classes. Standard symbols, equations, tables and figures in latex. Bibliography management using bibtex/natbib.

UNIT-III
Choosing a journal and methods of submission, predatory journals, DOI, ORCID, Manuscript submission and tracking, Types of manuscript. Checklist for manuscript submission. Revision of an article and dealing with rejection.

UNIT-IV
Referencing styles. Bibliometric indexes. Research ethics: Citing another publication, Plagiarism and similarity (checking tools). Journal Impact and indices of journal quality. Writing a research proposal. Ethical Dilemmas and etiquettes of scientific publication.

Textbook(s)/Reference(s):
1.Margaret Cargill and Patrick O'Connor, "Writing Scientific Research Articles", 2nd Edition, Wiley-Blackwell, 2013.
2.S.C. Parija and V. Kate (Editors), "Writing and Publishing a Scientific Research Paper", Springer, 2017
3. M. Jay Katz, "From Research to Manuscript," Springer, 2009
4. P. A. Laplante, "Technical Writing: A Practical Guide for Engineers and Scientists", CRC Press, 2012
5. G. Gratzer, "Practical Latex", Springer, 2014

Paper ID:		**L**	**T**	**C**
Code: ICT 513	**Paper: Wireless Sensor Networks**	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS:

Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks

Course Outcome:

CO 1	Introduction to WSN
CO 2	Explain MAC and routing
CO 3	Explain time synchronization and Localization
CO 4	Explain security in WSN

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	3	-	3	-
CO 2	3	-	3	-
CO3	3	-	3	-
CO4	3	-	3	-

UNIT-I

Introduction and overview: WSN, Applications of Sensor Networks, Sensor network architecture, Architecture of WSNs Hardware components, Energy consumption of sensor nodes, Operating systems and execution environments, some examples of sensor nodes, Network Architecture: Sensor networks scenarios, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.

UNIT-II

MAC and Routing: Physical Layer and Transceiver design considerations in WSNs, Fundamentals of MAC protocol: Low duty cycle protocols and wakeup concepts, Contention-based protocols, Schedule-based protocols, The IEEE 802.15.4 MAC protocol, Naming and addressing, Routing protocols

UNIT-III

Time Synchronization: Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols. Localization: Ranging Techniques, Range-Based Localization, Range-Free Localization, Event Driven Localization

UNIT-IV

Security: Network Security, Challenges of Security in Wireless Sensor Networks, Security Attacks in Sensor Networks, Protocols and Mechanisms for Security, IEEE 802.15.4 and Zig Bee Security, QoS in wireless sensor networks

Textbook(s):

1. Holger Karl and Andreas Willig , “Protocols and Architectures for Wireless Sensor Networks”, Wiley Publisher, 2014.
2.Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks: Theory and Practice”, Wiley 2010
3.Mohammad S. Obaidat, Sudip Misra, “Principles of Wireless Sensor Networks”, Cambridge, 2014

References:

1. C Siva Ram Murty & BS Manoj ,”Ad hoc Wireless Networks: Architectures & Protocols”, 2nd Ed, Pearson Education.
2.F. Zhao and L. Guibas, “Wireless Sensor Network: Information Processing Approach”, Elsevier, 2009
3. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks Technology, Protocols, and applications”, John Wiley & Sons, 2004

Paper ID:	**L**	**T**	**P**
Code: ICT515 Paper:Analog Integrated Circuit Design	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS:

Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks

Course Outcomes:

CO 1	Understanding the small signal models and approximations for analog circuit analysis and design.
CO 2	Understanding single stage amplifiers and designing amplifiers for given specifications.
CO 3	Understanding the design procedures of one and two stage operational amplifiers.
CO 4	Understanding the role of feedback in amplifier and stability.

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	3	-	3	-
CO 2	3	-	3	-
CO3	3	-	3	-
CO4	3	-	3	-

Unit–1:
Basic MOS Device Physics: General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models. Short Channel Effects and Device Models. Single Stage Amplifiers – Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage.

Unit-2:
Differential Amplifiers: Single Ended and Differential Operation, Basic Differential Pair, CommonMode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors – Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.

Unit-3:
Frequency Response of Amplifiers: General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair. Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential Pairs.

Unit-4:
Feedback Amplifiers: General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation.

Text Books:

1. Paul. R.Gray & Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley, 5th Edition, 2009.
2. B.Razavi, “Design of Analog CMOS Integrated Circuits”, 2nd Edition, McGraw Hill Edition 2016.

References:

1. Philip Allen & Douglas Holberg, CMOS Analog Circuit Design, Oxford University Press, 2002.
2. David A Johns & Ken Martin, Analog Integrated Circuit Design, John Wiley and Sons, 2001
3. R. Jacob Baker, “CMOS Circuit Design, Layout, and Simulation”, 3rd Edition, Wiley, 2010

Paper ID:	**L**	**T**	**P**
Code: ICT517 Paper: Advanced Electromagnetic Engineering	**4**	**0**	**4**

INSTRUCTIONS TO PAPER SETTERS:

Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks

Course Outcome:

CO 1	*Understand and apply Maxwell's equations and be able to explain their consequences under different assumptions*
CO 2	*Solve problems and do calculations related to electromagnetic radiation, motion of charged particles*
CO 3	*Derive and analyse models for electromagnetic fields and wave-propagation*
CO 4	*Know applications of radiation, scattering and bio electromagnetism.*

UNIT-I
Review of Maxwell equations, The Source Concept, Duality, Uniqueness, Image Theory, The Equivalence Principal, Fields in Half-space, The Induction Theorem, Reciprocity, Green's Function

UNIT-II
The Wave Function, Plane Waves, The Rectangular Waveguide, The Rectangular Cavity, Partially Filled Waveguide, The Dielectric-Slab Waveguide, Surface-Guided Waves, Modal Expansion of Fields, Current in Waveguides

UNIT-III
The Cylindrical and Spherical Wave Function, Inhomogeneous Field Waveguides, Discontinuity and Excitation of waveguides, The Circular Cavity and Other Guided Waves, Scattering.

UNIT-IV
Radiation from simple sources and apertures, Antenna Theory: Receiving antennas and various types of Antennas, Antenna pattern synthesis, Periodic structure, Floquet's Theorem, Other resonators: split-ring resonator, Spiral Resonator, fishnet structures. Introduction to bio-electromagnetism

Text Books:
[T1] C.A. Balmain, "Advanced Engineering Electromagnetics", Wiley India, 2005
[T2] Electromagnetic wave theory for boundary-value problems: an advanced course on analytical methods by HyoJ. Eom, 1 ed, Springer 2004
[T3] Introduction to Electrodynamics By David J. Griffith, John Wiley & Sons,3rd Edition.

Reference Books:
[R1] Time Harmonic Electromagnetic Fields By R.F Harrington, McGraw Hill, 1961.
[R2] Electromagnetic Wave Propagation, Radiation and Scattering, A. Ishimaru , Prentice Hall , 1991
[R3] Electromagnetic Waves and Radiating Systems By Jordan and Balmain, Pretice Hall,2nd Edition.

Paper Code: RA501	**Paper: Computational Methods using MATLAB**	**L**	**T/P**	**C**
Paper ID:		**3**	**-**	**3**

Prerequisite Paper: NIL

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instruction for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives:

1:	To impart basic knowledge about simple algorithms for various numerical methods so that students can understand how to write a program in 'MATLAB'.
2:	To impart knowledge about root finding methods and matrices
3:	To Evaluate numerical integration and differentiation techniques
4:	To impart knowledge about how to approach for ordinary differential equations

Course Outcomes (CO):

CO1:	Ability to write simple MATLAB programs related to numerical methods.
CO2:	Ability to implement different root finding algorithms
CO3:	Ability to implement trapezoidal and simpson's rules.
CO4:	Ability to solve ordinary differential equations and Fourier transform methods .

	PO1	PO2	PO3	PO4
CO1	3	-	3	-
CO2	3	-	3	-
CO3	3	-	3	-
CO4	3	-	3	-

Unit I

MATLAB Fundamentals:The MATLAB Environment,Assignment, Mathematical Operations,Use of Built-In Functions, Graphics,M-Files, Input-Output, Structured Programming,Nesting and Indentation,Passing Functions to M-Files,Types of Computer Errors, IEEE 64-bit Floating-Point Number Representation, Vectors in MATLAB
Finding Roots by Bracketing Methods and Open methods, Optimization: Unconstrained Optimization, Constrained Optimization, MATLAB Built-In Routines for Optimization

Unit II

Matrix Algebra Overview, Solving Linear Algebraic Equations with MATLAB, Gauss Elimination, LU Factorization,Cholesky Factorization, Matrix Inverse and Condition, Iterative Methods, Eigenvalues,

Interpolation and Curve Fitting: Interpolation by Lagrange, Newton, and Chebyshev Polynomial, Hermite Interpolating Polynomial, Cubic Spline interpolation, Straight Line, Polynomial Curve, and Exponential Curve Fit.

Unit III

Numerical Integration Formulas:Newton-Cotes Formulas, Trapezoidal Rule, Simpson's Rules, Romberg Integration, Gauss Quadrature,Adaptive Quadrature
Numerical Differentiation:Richardson Extrapolation, Derivatives of Unequally Spaced Data, Derivatives and Integrals for Data with Errors, Numerical Differentiation with MATLAB.

Unit IV

Ordinary Differential Equations: Euler's Method, Runge-Kutta Methods, Multistep Methods, Boundary-Value Problems
Fourier Analysis: Curve Fitting with Sinusoidal Functions, Continuous Fourier Series, Frequency and Time Domains, Fourier Integral and Transform, Discrete Fourier Transform (DFT)

Textbooks:

1. *Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven C. Chapra, McGraw Hill Education, 3rd ed,2017.*
2. *Introduction to Matlab for Engineers by William J. Palm III, McGraw Hill Education,2011*

References:

1. *Applied Numerical methods using MATLAB by W. Y. Yang, Wiley Publications, 2005*

Paper Code: RA503	**Paper: Robotics Engineering**	**L**	**T/P**	**C**
Paper ID:		**4**	**-**	**4**

Prerequisite Paper:

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instruction for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives:

1:	To impart knowledge about history of robots, classification of robots, robot anatomy and various drive systems used in robot.
2:	To impart knowledge of kinematics of robots.
3:	To impart knowledge of dynamics of robots.
4:	To impart knowledge about sensors used in robots. To impart basic knowledge about control system used in robot. To impart knowledge of programming languages used in robots along with case studies pertaining to robot application in industries.

Course Outcomes (CO):

CO1:	Ability to understand the various parts and their functioning used in robot. Ability to develop the knowledge of various drive systems used in robots.
CO2:	Ability to solve the problems of kinematic of robots.
CO3:	Ability to solve the problems of dynamics of robots.
CO4:	Ability to understand the various sensors used in robots. Ability to acquire the basic knowledge of the programming languages used in robots. Also, ability to understand the role of robots in industries through case studies.

	PO1	PO2	PO3	PO4
CO1	3	-	3	1
CO2	3	-	3	1
CO3	3	-	3	1
CO4	3	-	3	1

Unit I: Introduction

A brief history of robots, Automation and Robotics, Classification of robots, Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. End effectors, Grippers- Mechanical grippers, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot, Economic analysis for robots.

Drive Systems- hydraulic, pneumatic and electric systems.

Unit II: Kinematics of Robots

Descriptions of positions, orientation and frames, mapping of frames, transformations and operators, Euler angles and Euler transformations, D-H representation, Inverse kinematics, Time varying position and orientation, Linear and rotational velocity, Velocity propagation from link to link, Jacobians.

Unit III: Dynamics of Robots

Newton's equation, Euler's equation, Newton-Euler dynamic formulation, Lagrangian formulation of manipulator dynamics, Dynamic equations for multiple DOF robots, Static force analysis of robots.

Trajectory generation: Basics of trajectory planning, Cartesian space trajectories.

Unit IV: Sensors, Robot Control, Programming and applications

Sensors in robot: Introduction of various sensors used in manipulator.

Robot controls: Point to point control, Continuous path control, Control system for robot joint, Feedback devices, Motion Interpolations, Adaptive control.

Introduction to Robotic Programming, On-line and off-line programming, programming examples.

Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting.

Textbooks:

1. *Mikell P. Groover, Mitchel Weiss, Roger N Nagel, Nicholas G. Odrey, Ashish Dutta, "Industrial Robotics: Technology programming and Applications", McGraw Hill, 2012.*
2. *John J. Craig. "Introduction to Robotics- Mechanics and Control", Third Edition,Addison- Wesley, 2004.*

References:

1. *S.R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education., 2009.*
2. *Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning., 2009.*
3. *C. Ray Asfahl, "Robots and Manufacturing Automation", John Wiley & Sons Inc.,1985*
4. *Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008.*

Paper Code: RA505	**Paper: Mechatronics Systems and applications**	**L**	**T/P**	**C**
Paper ID:		**3**	**-**	**3**

Prerequisite Paper:

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instruction for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives:

1:	To understand functioning of mechatronic systems
2:	To understand the basicfunctioning of Mechanical, Hydraulic,Pneumatic, and Electrical actuation systems inmechatronics system design
3:	To understand the basicfunctioning of controllers, processors andProgrammable logic control (PLC) actuationsystems in mechatronics system design
4:	To understand how mechatronic systems can be designed for industrial and household processes.

Course Outcomes (CO):

CO1:	Ability to understand the basicfunctioning of mechatronics system and use of sensors, transducers and their importancewith respect to precision and accuracy inapplications of mechatronics systems.
CO2:	Ability to understand the basicfunctioning of Mechanical, Hydraulic,Pneumatic, and Electrical actuation systems inmechatronics system design. Students will getpractical hands on exposure to simulationsoftware and environment
CO3:	Ability to understand the basicfunctioning of controllers, processors andProgrammable logic control (PLC) actuationsystems in mechatronics system design.
CO4:	Ability to conceptualizemechatronics for automation of industrial andhousehold processes to solve variousproblems and simulations.

	PO1	PO2	PO3	PO4
CO1	3	-	3	-
CO2	3	-	3	-
CO3	3	-	3	-
CO4	3	-	3	-

Unit I

Introduction: Introduction to Mechatronics System, mechatronics in manufacturing, product and design, Measurement Systems, Control System, comparison between traditional and mechatronics approach.
Sensors and Transducers: Introduction, Performance terminology, Displacement, Position and Proximity, Velocity and motion, Fluid pressure, Temperature sensors, Light sensors, Selection of sensors.

Unit II

Mechanical Actuation System: Cams, Gear trains, Ratchet and Pawl, Belt and chain drives, Bearings.
Hydraulic and Pneumatic Actuation System: Introduction to Hydraulic and Pneumatic Systems, Directional Control valves, Flow control valves.
Electrical Actuation System: Electrical systems, Solid State Switches, Solenoids, D.C. motors, A.C. motors, Stepper motors.

Unit III

Microprocessors: Microprocessor systems, Microcontrollers, applications.
Programmable Logic Controllers: Basic PLC structure, Input/output processing, ladder programming, latching and internal relays, Sequencing, Timers and counters, Shift registers, Master and jump controls, Code conversion, Data handling, selection of PLC.

Unit IV

System Models: Mathematical models, Mechanical, Electrical, hydraulic and Thermal Systems, Modelling of dynamic systems.

Design of Mechatronics systems: Stages in designing mechatronics system, Traditional and Mechatronic design.
Case studies of Mechatronics system: Pick and place robots, automated guided vehicle, Automatic car park barrier, Engine management system

Textbooks:

1. W.Bolton, "Mechatronics" , Pearson education, second edition, fifth Indian Reprint, 2003
2. A. Smaili and F. Mrad, "Mechatronics- integrated technologies for intelligent machines", Oxforduniversity press, 2008.

References:

1. R.K Rajput, A textbook of mechatronics, S. Chand & Co, 2007
2. Michael B. Histand and David G. Alciatore, " Introduction to Mechatronics and MeasurementSystems", McGraw-Hill International Editions, 2000.
3. D. A. Bradley, Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall,1993.
4. Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).
5. Lawrence J. Kamm, "Understanding Electro – Mechanical Engineering", An Introduction toMechatronics, Prentice – Hall of India Pvt., Ltd., 2000.
6. Nitaigour Premchand Mahadik, "Mechatronics", Tata McGraw-Hill publishing Company Ltd,2003.

Paper Code: RA507	**Paper: Introduction to Manufacturing Systems** (For CSE/IT/ECE/ICE/EE background students)	**L**	**T/P**	**C**
Paper ID:		**4**	**-**	**4**

Prerequisite Paper: NIL

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instruction for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives:

1:	To develop an understanding of manufacturing processes and their applications. To develop an understanding of various types of welding methods, and their uses.
2:	To develop an understanding of various material removal processes, and their uses.
3:	To be familiar with milling, grinding and gear cutting operations. To develop an understanding of non-conventional machining processes, and will be aware of applications of conventional or non-conventional machining processes.
4:	To be aware of and be able to plan the process, product and layout of industry. To develop fair knowledge of metrological aspects in manufacturing processes. To be familiar with various types of automations and uses of ICT in machining industries.

Course Outcomes (CO):

CO1:	The students will have overview of manufacturing processes. They will also have understanding of various welding methods.
CO2:	The students will learn about various metal removal processes.
CO3:	The students will understand various types of milling operations along with the understanding of noon-conventional machining processes.
CO4:	The students will have introduction of process planning, metrology and numeric control of machines.

	PO1	PO2	PO3	PO4
CO1	3	-	3	-
CO2	3	-	3	-
CO3	3	-	3	-
CO4	3	-	3	-

UNIT-I

Definition of manufacturing, Overview of manufacturing processes.
Welding Processes- Definition of welding, Gas Welding, Electric Arc Welding- Principle of arc, arc welding equipment, manual metal arc welding. Resistance welding- Principle, Resistance spot welding, Resistance seam welding. Electron beam welding, Laser beam welding, Brazing, Soldering.

UNIT-II

Metal Removal Processes- Introduction of metal removal processes, Concept of chip formation, Orthogonal and oblique cutting, Classification of machine tools, Generation and forming, methods of generating surfaces, Basic elements of machine tools, Introduction to centre lathe, Operations performed on centre lathe.
Reciprocating Machine Tools - Shaper, Planer, Slotter.

UNIT-III

Milling- Introduction, Types of milling machines.
Hole Making Operations- Introduction to Drilling, Boring, Reaming, Tapping.
Grinding- Introduction, Grinding wheel-abrasive type, grain size; Types of grinding machines - cylindrical grinding, surface grinding, centre less grinding, Honing, Lapping.
Introduction to Gear cutting operations.
Unconventional Machining Processes - Working principles of EDM, ECM, USM, LBM.

UNIT-IV:
Process Planning- Concept of process planning, Product cycle in manufacturing, Product Quality, Accuracy of machining, Accuracy of assembly.
Metrology- Tolerance, Limits and Fits, Hole basis system, Linear measurement, Slip gauges, comparators, Angular measurement.
Numeric Control of Machine Tools- Numeric control, NC machine tools, Introduction to CNC and DNC.

Textbooks:
[T1] P.N.Rao, "Manufacturing Technology-Metal Cutting and Machine Tools", TMH.
[T2] M.P.Groover, "Fundamentals of Modern Manufacturing", Wiley India Pvt., Ltd.
[T3] M.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", PHI

Reference Books:
[R1] Serope Kalpakjian and Steven R. Schimid, "Manufacturing Processes", Pearson.
[R2] Gerling Heinrich, “All about Machine Tools”, New Age Publication, 2003.

Paper Code: RA 509	**Paper: Introduction to Electrical and Electronics Systems** (for MAE/ME/Production/Industrial Engg background students) Engineering	**L**	**T/P**	**C**
Paper ID:		**4**	**-**	**4**

Prerequisite Paper: NIL

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instruction for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives:

1:	To impart knowledge about electrical circuits using various methods of circuit analysis.
2:	To impart knowledge of working principle and characteristics of various DC Machines.
3:	To impart knowledge of structure and operation of basic electronic devices such as p-n junction Diodes, BJT, MOSFETs.
4:	To impart knowledge about digital electronics and designing of combinational circuits.

Course Outcomes (CO):

CO1:	Ability to solve electrical circuits using various methods of circuit analysis.
CO2:	Ability to explain the working principle and characteristics of various DC Machines.
CO3:	Get familiar with the structure and operation of basic electronic devices such as p-n junction Diodes, BJT, MOSFETs.
CO4:	Understanding of the basic concepts of digital electronics and able to identify, analyze and design combinational circuits.

	PO1	PO2	PO3	PO4
CO1	3	-	3	-
CO2	3	-	3	-
CO3	3	-	3	-
CO4	3	-	3	-

Unit I

Review of DC and AC circuits.

Introduction of DC Circuit parameters and energy sources (Dependent and Independent), Mesh and Nodal Analysis, Superposition, Thevenin's, Norton's, Reciprocity, Maximum Power Transfer and Millman's Theorems.

Unit II

Introduction to DC and Induction motors (both three phase and single phase), Stepper Motor and Permanent Magnet Brushless DC Motor. Speed and Torque Equation of D.C. motors, Characteristics of D.C. series, shunt and compound motors and their applications, Starting and speed control of D.C. motors, Braking of D.C. motors, Efficiency and testing of D.C. Machines, Introduction of D.C. servo motor and permanent magnet / brushless D.C. motors.

Unit III

Review of p-n junction diode.

Introduction to BJT and MOSFETS, hybrid model for transistor at low frequencies.

Digital and analog signals, number systems, Boolean algebra, Switching Theory: - Boolean Algebra- Postulates and Theorems, De' Morgan's Theorem, Switching Functions- Canonical Forms- logic gates with simple applications, logic gates, Simplification of Switching Functions- Karnaugh Map and Quine Mc-Clusky Methods.

Unit IV

Number Systems and Codes:- Decimal, Binary, Octal and Hexadecimal Number systems, Codes- BCD, Gray Code, Excess-3 Code, ASCII, EBCDIC, Conversion between various Codes.

Combinational Logic Circuits:- Review of basic gates- Universal gates, Adder, Subtractor ,Serial Adder, Parallel Adder- Carry Propagate Adder, Carry Look-ahead Adder, Carry Save Adder, Comparators, Parity Generators, Decoder and Encoder, Multiplexer and De-multiplexer, ALU, PLA and PAL.

Textbooks:

1. *S.N. Singh, "Basic Electrical Engineering", PHI India Ed 2012.*
2. *Chakrabarti, Chanda,Nath "Basic Electrical Engineering" TMH India", Ed 2012*
3. *Morris Mano, Digital Logic and Computer Design", Pearson*
4. *R.P.Jain, "Modern Digital Electronics", TMH, 2nd Ed.*

References:

1. *ZyiKohavi, "Switching & Finite Automata Theory", TMH, 2nd Edition*
2. *S.Salivahanan, A. Vallavaraj, C. Gnanapriya, "Digital Signal Processing", Tata McGraw Hill International/TMH, 2007.*

Paper Code: RA513	**Paper: Control system and application**	**L**	**T/P**	**C**
Paper ID:		**3**	**-**	**3**

Prerequisite Paper:

Marking Scheme:

3. Teachers Continuous Evaluation: 25 marks
4. Term end Theory Examinations: 75 marks

Instruction for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives:

1:	To understand the open loop and closed loop (feedback) systems.
2:	Explain the input output relationship of simple control system components
3:	Understand various automatic control actions used in control system.
4:	Understanding of control systems for automation applications.

Course Outcomes (CO):

CO1:	Ability to solve and design the open and closed loop system.
CO2:	Ability to understand conventional and digital control systems
CO3:	Ability to understand the concept of controllability and observability
CO4:	Ability to learn the functionality of different motors for control systems

	PO1	PO2	PO3	PO4
CO1	3	-	3	-
CO2	3	-	3	-
CO3	3	-	3	-
CO4	3	-	3	-

Unit I

Elements of Control System – Open loop and Closed loop systems – Differential equation – Transfer function, Modelling of Electric and Mechanical systems, Translational and rotational mechanical systems, Block diagram reduction Techniques, Signal flow graph, P,PI,PD and PID Compensation, concept of Stability, Routh-Hurwitz Criterion.

Unit II

Digital control: Introduction to Discrete Time Systems, Necessary for Digital Control System, Spectrum Analysis of Sampling Process, Signal Reconstruction, Difference Equations, Z transforms, and the Inverse Z transform, Pulse Transfer Function, Time Response of Sampled Data Systems.

Unit III

State variable Analysis: Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability. Introduction to Optimal control & Nonlinear control, Optimal Control problem, Regulator problem, Output regulator, tracking problem, Nonlinear system – Basic concepts.

Unit IV

Control Systems for Automation: Working principle of synchronous, Asynchronous & stepper motors, Difference between Induction and servo motors, Torque v/s speed characteristics, Power v/s. Speed characteristics, Industrials Drives: DC and AC motors operation and selection, Selection of feedback system. Introduction to Embedded Systems, Architecture and system Model, Embedded Hardware Building Block, embedded system on chip (SOC).

Textbooks:

3. *K. Ogata, "Modern control engineering", Pearson 2002.*
4. *Control System Engineering, J. Nagrath and M. Gopal, New Age International publishers,5th Edition, 2007.*
5. *Sigurd Skogestad and Ian Postlethwaite, Multivariable Feedback Control Analysis and Design – John Wiley & Sons Ltd., 2nd Edition, 2005*
6. *Digital control systems by K.Ogata*
7. *Embedded Systems- Architecture, Programming and Design, Raj Kamal, Tata McGraw HIll Education.*
8. *Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8th edition.*

References:

7. *Donald Eckman, "Automatic Process Control", Wiley Eastern Limited.*
8. *Thomas E Marlin "Process Control- Designing processes and Control Systems for Dynamic Performance", McGraw-Hill International Editions.*
9. *F. G. Shinskey, "Process control Systems", TMH.*
10. *Krishna Kant, "Computer Based Industrial Control", PHI.*
11. *Chi-Tsong Chen, "Linear System Theory and Design", Oxford University Press.*
12. *B. C. Kuo, "Automatic Control System", Prentice Hall of India, 7th edition 2001*