SCHEME and SYLLABUS

for

BACHELOR OF TECHNOLOGY

in

ROBOTICS AND ARTIFICIAL INTELLIGENCE

(w.e.f. session 2023-2024)

(Choice Based Credit Scheme)

DEPARTMENT OF MECHANICAL ENGINEERING

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

The scheme and Syllabus approved in 21st BOS (UG) held on 24.03.2023; Item No. BOS/21/03

J.C. Bose University of Science & Technology, YMCA, Faridabad
(A Haryana State Government University)
(Established by Haryana State Legislative Act No. 21 of 2009 & Recognized by UGC Act 1956 u/s 22 to Confer Degrees)
Accredited 'A' Grade by NAAC

Ref. No. _____ Dated: 25.05.2023

CERTIFICATE

This is to certify that the scheme & syllabi of B.Tech (Robotics & Artificial Intelligence) (course name & scheme) is duly approved by the competent body/authority and to the best of my knowledge the contents of the same, are correct in all respect.

This Scheme & Syllabus has been approved in 21st (meeting no.) of BOS held on dated 24.03.2023; Item No.- BOS/21/03

Date: 25.05.2023

Chairman
Department of Mechanical Engineering
J.C. Bose University of Sc. and Tech., YMCA
Sector-6, Faridabad-121006
25/05/23

Signature & Stamp of Chairperson
Name: Prof. Arvind Gupta
Deptt. Name Mechanical Engg.

25.5.2023
(Syllabus Coordinator)
Dr Sandhya Dixit, ME

VISION

"J.C. Bose University of Science & Technology, YMCA, Faridabad aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building."

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the-art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities.

Department of Mechanical Engineering

VISION

"To be a centre of excellence by producing high caliber, competent and self-reliant mechanical engineers, who possess scientific temperament and would engage in activities relevant to industries with ethical values and flair to research."

MISSION

- To provide efficient engineers for global requirements by imparting quality education.
- To explore, create and develop innovations in various aspects of engineering through industries and institutions.
- To emphasize on practical skills and socially relevant technology.

ABOUT THE DEPARTMENT

J.C. Bose University of Science & Technology, YMCA, Faridabad established in 2009, formerly known as YMCA Institute of Engineering, Faridabad, was established in year 1969 as a Joint Venture of Govt. of Haryana and National Council of YMCAs of India with active assistance from overseas agencies of West Germany to produce highly practical oriented personnel in specialized fields of engineering to meet specific technical manpower requirements of industries. Mechanical Engineering department was started in 1969 and has been conducting 4 years B.Tech. Course in Mechanical Engineering since 1997 with an intake of '60' students and subsequently, it was increased to '75' in 1999, '90' in 2004 and '120' in 2007. Students are admitted through centralized counselling conducted by State Government. Presently, the total intake for the B.Tech. programme in Mechanical Engineering is 120 and 12 through LEET in second year. Besides B.Tech. in Mechanical Engineering, B.Tech. in Robotics and Artificial Intelligence has also been started with an intake of 30 since 2021. The department is also running M.Tech. in Manufacturing Technology and Automation with an intake of 18 and PhD. All programmes are duly approved by AICTE/ UGC. B.Tech. (Mechanical Engineering) and M.Tech. (Manufacturing Technology and Automation) are NBA accredited. The department has started minor degree in 'Robotics' from session 2023-24 onwards. The Mechanical Engineering department has been well known for its track record of employment of the pass out students since its inception.

The department has a separate building with ICT enabled class rooms, state of the art laboratories, research lab, workshops, seminar room, conference hall and departmental library. It has established Centre of Excellence with (i) M/s Danfoss India (P) Ltd. in the area of 'Climate and Energy'; (ii) M/s Daikin (P) Ltd. in the field of 'Refrigeration and Air Conditioning'; (iii) M/s BOSCH for the training in automotive diagnostic equipment; (iv) Royal Enfield for service training. It has well qualified and experienced faculty. The syllabi of UG/PG courses in Mechanical Engineering department have been prepared with active participation from Industry. One semester Industrial training is mandatory for every B.Tech. student. Emphasis has been given on project work and workshop for skill enhancement of students. Choice based credit system (CBCS) allows students to study the subjects of his/her choice from a number of elective courses /audit courses.

PREAMBLE

B.Tech. (Robotics and Artificial Intelligence) program run by the department of Mechanical Engineering prepare the students to undertake careers in core and allied engineering works. The various courses under this program are designed with a holistic approach towards Mechanical, Electronics and Computer Engineering combined together. The theoretical concepts along with practical experience and skill sets gained will provide an edge for future endeavours specifically in the area of Robotics and Artificial Intelligence. The scheme and syllabus have been framed with a perception to provide the students an integrated flavour of Mechanical, Electronics and Computer Engineering in order to meet the global expectations in allied areas.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO-1

To train students with practical skills and experimental practices related to core and applied areas of Robotics and Artificial Intelligence to expand their knowledge horizon beyond books.

PEO-2

To enable students to design, develop and maintain mechatronics and automation systems which are useful for the society.

PEO-3

To improve team building, team working and leadership skills of the students with high regard for ethical values and social responsibilities.

PEO- 4

To enable students to communicate effectively and demonstrate the knowledge of project management and independent research.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1) **Engineering Knowledge:** Apply knowledge of Mathematics, Science, Engineering fundamentals, and Robotics and Artificial Intelligence to the solution of engineering problems.

2) **Problem Analysis:** Identify, formulate, review literature and analyze Robotics and Artificial Intelligence problems to design, conduct experiments, analyze data and interpret data.

3) **Design /Development of Solutions:** Design solution for Robotics and Artificial Intelligence problems and design system component of processes that meet the desired needs with appropriate consideration for the public health and safety, and the cultural, societal and the environmental considerations.

4) **Conduct Investigations of Complex Problems**: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in Robotics and Artificial Intelligence.

5) **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to Robotics and Artificial Intelligence activities with an understanding of the limitations.

6) **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to Robotics and Artificial Intelligence practice.

7) **Environment and Sustainability:** Understand the impact of the Robotics and Artificial Intelligence solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.

8) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the Robotics and Artificial Intelligence practice.

9) Individual and Team Work: Function affectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings in Robotics and Artificial Intelligence.

10) Communication: Communicate effectively on complex engineering activities with the engineering committee and with society at large, such as, being able to comprehend and write affective reports and design documentation, make effective presentations in Robotics and Artificial Intelligence.

11) Project Management and Finance: Demonstrate knowledge & understanding of the Robotics and Artificial Intelligence principles and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments in Robotics and Artificial Intelligence.

12) Life- Long Learning: Recognize the need for, and the preparation and ability to engage in independent research and lifelong learning in the broadest contest of technological changes in Robotics and Artificial Intelligence.

PROGRAM SPECIFIC OUTCOMES (PSOs):

1) Ability to assimilate the knowledge and skills of Robotics and Artificial Intelligence in their profession.

2) Ability to innovate in specific aspects of Robotics and Artificial Intelligence for social well-being, maintaining high standards of ethical values.

SCHEME OF STUDIES & EXAMINATIONS

FOUR YEARS BACHELOR OF TECHNOLOGY PROGRAMME IN

ROBOTICS AND ARTIFICIAL INTELLIGENCE

SEMESTER I – VIII (w. e. f. Session 2023-24)

B. TECH SCHEME CREDITS CALCULATIONS

S. No.	Category of Courses	Contact Hours	Credits
1.	Programme Core Courses (PCC)	81	71
2.	Basic Science Courses (BSC)	41	38
3.	Engineering Science Courses (ESC)	29	20
4.	Humanities and Social Sciences including Management Courses (HSMC)	4	3
5.	Programme Elective Courses (PEC)	15	15
6.	Open Elective Courses (OEC)	9	9
7.	Skill Enhancement Courses (SEC)	20	20
8.	Mandatory Audit Courses (MAC)	4	0
9.	Massive Open Online Courses (MOOCS)*	-	-
10.	Value Added Courses (VAC)**	-	-
11.	Induction Program	-	-
	Total	**203**	**176***

Note: * It is mandatory to pass the MOOC course(s) by all the students as per implementation of credit transfer/ mobility policy of online courses of the University-as mentioned in Annexure at the end of the syllabus. (One MOOC is to be completed every year of minimum 3 credits)

**** Value Added Courses are floated and conducted in the department from time to time for Skill enhancement/ Employability/ Imparting Ethical Values to the Students.**

MANDATORY INDUCTION PROGRAM (3-WEEKS DURATION)

When new students enter an institution, they come with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose. A 3-week long induction program for the UG students entering the institution, right at the start, has to be planned. Normal classes will start only after the induction program is over. Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

Tentative activities which can be planned in this Induction Programme are as follows:

• Physical Activity

• Creative Arts

• Universal Human Values

• Literary

• Proficiency Modules

• Lectures by Eminent People

• Visits to Local Area

• Familiarization to Dept./Branch & Innovations

SEMESTER WISE SUMMARY OF THE PROGRAMME

S.No.	Semester	Contact Hours	Marks	Credits
1.	I	25 per week	650	19.5
2.	II	29 per week	700	21.5
3.	III	33 per week	900	29
4.	IV	31 per week	850	24
5.	V	27 per week	800	23
6.	VI	31 per week	900	25
7.	VII	27 per week	850	24
8.	VIII	One Semester	500	10
	Total	**203**	**6150**	**176**

PROGRAMME CORE COURSES (PCC)

S. No.	Code	Name of the Course	Contact Hours	Credits	Semester
1.	PCC-RAI-301/21	Materials Engineering	4	4	III
2.	PCC-RAI-302/21	Basics of Electronics Engineering	3	3	III
3.	PCC-RAI-303/21	Data Structure	4	4	III
4.	PCC-RAI-304/21	Digital Electronics	4	4	III
5.	PCC-RAI-305/21	Basics of Electronics Engineering Lab	2	1	III
6.	PCC-RAI-306/21	Data Structure Lab	2	1	III
7.	PCC-RAI-401/21	Kinematics of Robots	4	4	IV
8.	PCC-RAI-402/21	Artificial Intelligence	3	3	IV
9.	PCC-RAI-403/21	Design of Machine Elements	3	3	IV
10.	PCC-RAI-404/21	Microprocessor and Microcontroller	3	3	IV
11.	PCC-RAI-405/21	Mechatronics System Design	3	3	IV
12.	PCC-RAI-406/21	Artificial Intelligence Lab	2	1	IV
13.	PCC-RAI-407/21	Microprocessor and Microcontroller Lab	2	1	IV
14.	PCC-RAI-408/21	Kinematics of Robots Lab	2	1	IV
15.	PCC-RAI-501/21	CAD/CAM	3	3	V
16.	PCC-RAI-502/21	Digital Signal Processing	3	3	V
17.	PCC-RAI-503/21	Machine Learning and Application	3	3	V
18.	PCC-RAI-504/21	Communication Systems	3	3	V
19.	PCC-RAI-505/21	Design and Fabrication Lab	2	1	V
20.	PCC-RAI-506/21	Python Programming Lab	2	1	V
21.	PCC-RAI-601/21	Introduction to IOT	3	3	VI
22.	PCC-RAI-602/21	Control Systems	3	3	VI
23.	PCC-RAI-603/21	Soft Computing	3	3	VI
24.	PCC-RAI-604/21	IOT Lab	2	1	VI
25.	PCC-RAI-605/21	Control Systems Lab	2	1	VI
26.	PCC-RAI-701/21	Additive Manufacturing	3	3	VII
27.	PCC-RAI-702/21	Deep Learning Principles and Practices	3	3	VII
28.	PCC-RAI-703/21	Mechanical Vibrations	3	3	VII
29.	PCC-RAI-704/21	Additive Manufacturing Lab	2	1	VII
		Total	**81**	**71**	

BASIC SCIENCE COURSES (BSC)

S. No.	Code	Name of Course	Contact Hours	Credits	Semester
1.	BSC-103RAI	Mathematics-I	4	4	I
2.	BSC-102	Chemistry	4	4	I
3.	BSC-105	Chemistry Lab	3	1.5	I
4.	BSC-101G	Physics (Electromagnetism and Basic Electronics)	4	4	II
5.	BSC-106RAI	Mathematics- II	4	4	II
6.	BSC-104A	Physics Lab	3	1.5	II
7.	MCEVS-01	Environment and Ecology	3	3	II
8.	BSC-301RAI	Mathematics-III (Linear Algebra and Numerical Methods)	3	3	III
9.	BSC-01	Biology	3	3	III
10.	MCEVS-02	National Resources and Biodiversity Conservation	3	3	IV
11.	BSC-501RAI	Probability and Statistics	4	4	V
12.	MCEVS-03	Environment Pollution, Waste Management and Sanitation	3	3	VI
		Total	**41**	**38**	

ENGINEERING SCIENCE COURSES (ESC)

S. No.	Code	Name of Course	Contact Hours	Credits	Semester
1.	ESC-101A	Basic Electrical Technology	4	4	I
2.	ESC-107A	Basic Electrical Technology Laboratory	2	1	I
3.	ESC-104A/21	Workshop- I	4	2	I
4.	ESC-103	Programming for Problem Solving	3	3	II
5.	ESC-105	Programming for Problem Solving Lab	4	2	II

6.	ESC-102A/21	Engineering Graphics and Drawing	4	2	II
7.	ESC-106A/21	Workshop- II	4	2	II
8.	ESC-303RAI/21	Engineering Mechanics	4	4	III
		Total	**29**	**20**	

HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT COURSES (HSMC)

S. No.	Code	Name of Course	Contact Hours	Credits	Semester
1.	HSMC-101	English	2	2	I
2.	HSMC-102	English Lab	2	1	I
		Total	**4**	**3**	

PROGRAMME ELECTIVE COURSES (PEC)

S. No.	Name of Course	Contact Hours	Credits	Semester
1.	Programme Elective Course I	3	3	VI
2.	Programme Elective Course II	3	3	VI
3.	Programme Elective Course III	3	3	VII
4.	Programme Elective Course IV	3	3	VII
5.	Programme Elective Course V	3	3	VII
	Total	**15**	**15**	

OPEN ELECTIVE COURSES (OEC)

S. No.	Name of Course	Contact Hours	Credits	Semester
1.	Open Elective Course I	3	3	V
2.	Open Elective Course II	3	3	VI
3.	Open Elective Course III	3	3	VII
	Total	**9**	**9**	

SKILL ENHANCEMENT COURSES (SEC)

S. No.	Code	Name of Course	Contact Hours	Credits	Semester
1.	SEC-RAI-301/21	Project I	4	2	III
2.	SEC-RAI-401/21	Project II	4	2	IV
3.	SEC-RAI-501/21	Project III	4	2	V
4.	SEC-RAI-601/21	Project IV	4	2	VI
5.	SEC-RAI-701/21	Project V	4	2	VII
6.	SEC-RAI-801/21	Industrial Training	One semester	10	VIII

		Total	**20**	**20**	

MANDARORY AUDIT COURSES (MC)

S. No.	Code	Name of Course	Contact Hours	Credits	Semester
1.	MC-02	Essence of Indian Traditional Knowledge	2	0	IV
2.	MC-04G	Message of Bhagavad Gita	2	0	VI
		Total	**4**	**0**	

VALUE ADDED COURSES (VAC)

S. No.	Code	Name of Course	Contact Hours	Credits	Semester
1.	HSMC (H-102)	Universal Human Values 2: Understanding Harmony	3	0	-
2.	VAC01	Human Values and Professional Ethics	3	0	-
		Total	**6**	**0**	

PROGRAMME ELECTIVE COURSE-I (PEC-I) (Semester-VI)

S. No.	Code	Name of Course	Contact Hours	Credits
1	PEC-RAI-601/21	Software Engineering	3	3
2.	PEC-RAI-602/21	Operating System	3	3
3.	PEC-RAI-603/21	Theory of Optimization Techniques	3	3
4.	PEC-RAI-604/21	Cloud Computing	3	3

Note: Students will have to select any one out of the list.

PROGRAMME ELECTIVE COURSE-II (PEC-II) (Semester-VI)

S. No.	Code	Name of Course	Contact	Credits

			Hours	
1.	PEC-RAI-611/21	Mobile Communication Network	3	3
2.	PEC-RAI-612/21	Wireless Communication	3	3
3.	PEC-RAI-613/21	Wireless Sensor Networks	3	3
4.	PEC-RAI-614/21	Smart Sensor and Sensor Network	3	3

Note: Students will have to select any one out of the list.

PROGRAMME ELECTIVE COURSE-III (PEC-III) (Semester- VII)

S. No.	Code	Name of Course	Contact Hours	Credits
1.	PEC-RAI-701/21	Operations Research	3	3
2.	PEC-RAI-702/21	Design Optimization	3	3
3.	PEC-RAI-703/21	Product Design and Development	3	3
4.	PEC-RAI-704/21	Total Quality Management	3	3
5.	PEC-RAI-705/21	Operations Management	3	3
6.	PEC-RAI-706/21	Value Engineering	3	3

Note: Students will have to select any one out of the list.

PROGRAMME ELECTIVE COURSE-IV (PEC-IV) (Semester- VII)

S. No.	Code	Name of Course	Contact Hours	Credits
1.	PEC-RAI-711/21	Metallurgy	3	3
2.	PEC-RAI-712/21	Composite Materials	3	3
3.	PEC-RAI-71321	Modeling, Simulation and Optimization	3	3
4.	PEC-RAI-714/21	Micro and Nano Manufacturing	3	3
5.	PEC-RAI-715/21	Introduction to NC, CNC Programming	3	3

Note: Students will have to select any one out of the list.

PROGRAMME ELECTIVE COURSE-V (PEC-V) (Semester-VII/ VIII)

S. No.	Code	Name of Course	Contact Hours	Credits
1.	PEC-RAI-721/21	Process Planning and Cost Estimation	3	3
2.	PEC-RAI-722/21	Non-Conventional Energy Resources Utilization	3	3
3.	PEC-RAI-723/21	Manufacturing Processes	3	3
4.	PEC-RAI-724/21	Finite Element Analysis	3	3
5.	PEC-RAI-725/21	New Venture Creation	3	3

Note: Students will have to select any one out of the list.

OPEN ELECTIVE COURSES- I (OEC- I) (Semester V)

Students have to select any one Open Elective Course-I from the list of courses offered by Computer Engineering Department or the Civil Engineering Department:

Courses offered by Computer Engineering Department

S. No.	Code	Name of Course	Contact Hours	Credits	Common with
1.	OEC-RAI-502	Cyber laws and Security	3	3	OEC-ME-502
2.	OEC-RAI-504	Web Technology and Information Retrieval	3	3	
3.	OEC-RAI-505	Intellectual Property and Rights	3	3	OEC-ME-505

Courses offered by Civil Engineering Department

S. No.	Code	Name of Course	Contact Hours	Credits	Common with
1.	OEC-RAI-506	Basic Environmental Engineering	3	3	OEC-ME-506
2.	OEC-RAI-507	Traffic Engineering and Management	3	3	OEC-ME-507
3.	OEC-RAI-508	Contracts Management	3	3	OEC-ME-508

4.	OEC-RAI-509	Solid and Hazardous Waste Management	3	3	OEC-ME-509
5.	OEC-RAI-510	Air and Noise Pollution and Control	3	3	OEC-ME-510

OPEN ELECTIVE COURSES- II (OEC- II) (Semester VI)

Students have to select any one Open Elective Course-II from the list of courses offered by Electrical Engineering Department or the Electronics Engineering Department:

Courses offered by Electrical Engineering Department

S. No.	Code	Name of Course	Contact Hours	Credits
1.	ELPE411	Electrical Energy Conservation and Auditing	3	3
2.	ELPE412	Industrial Electrical System	3	3
3.	ELPE612	Electrical and Hybrid Vehicles	3	3
4.	ELPE614	Wind and Solar Energy System	3	3

Courses offered by Electronics Engineering Department

S. No.	Code	Name of Course	Contact Hours	Credits	Common with
1.	OEC-RAI-606	Microprocessor and Interfacing	3	3	OEC-ME-606
2.	OEC-RAI-608	Digital Signal Processing	3	3	OEC-ME-608
3.	OEC-RAI-610	Instrumentation and Control	3	3	OEC-ME-610
4.	OEC-RAI-612	Data Communication and Networking	3	3	OEC-ME-612

OPEN ELECTIVE COURSES- III (OEC- III) (Semester VII/ VIII)

Students have to select any one Open Elective Courses-III from the list of courses offered by Humanities Department or the Management Department:

Courses offered by HAS Department

S. No.	Code	Name of Course	Contact Hours	Credits	Common with
1.	OEC-RAI-442	Soft Skills for Engineers	3	3	OEC-ME-442
2.	OPHL-306A	Physics and Our World	3	3	
3.	OPHL-305A	Introduction to Astrophysics and Cosmology	3	3	
4.	OES-301A	Waste Management in our Daily Life	3	3	
5.	OES-302A	Environmental Conservation	3	3	

Courses offered by MBA Department

S. No.	Code	Name of Course	Contact Hours	Credits	Common with
1.	OEC-RAI-444	Human Resource Management	3	3	OEC-ME-444
2.	OEC-RAI-446	Finance and Accounting	3	3	OEC-ME-446
3.	OEC-RAI-450	Entrepreneur Development	3	3	OEC-ME-450
4.	OEC-RAI-452	Economics for Engineers	3	3	OEC-ME-452

GRADING SCHEME

Marks %	Grade	Grade points	Category
90-100	O	10	Outstanding
80≤ marks<90	A+	9	Excellent
70≤marks< 80	A	8	Very good
60≤ marks< 70	B+	7	Good
50≤ marks< 60	B	6	Above average
45≤ marks< 50	C	5	Average
40≤marks< 45	P	4	Pass
<40	F	0	Fail
	Ab	0	Absent

Percentage calculation= CGPA * 9.5

Cumulative Grade Point Average (CGPA)

A student is required to maintain a Cumulative Grade Point Average (CGPA) which is the weighted average of all the Letter Grades obtained by the student since his/ her entry into the University upto and including the latest semester and is computed as follows:

$$CGPA= \sum(C_i G_{i)} / C_i$$

Where, C_i denotes the credits assigned to i^{th} course and G_i indicates the Grade Point Equivalent to the Letter Grade obtained by the student to the i^{th} course. Provided that when a student re-appears in/ repeats a course, the new Grade will replace the earlier one in the calculation of the CGPA.

Note: At the end of the semester (i.e. after End Semester Examination), students will be supplied a DMC indicating the grades secured in each course, Semester Grade Point Average (SGPA) and up-to-date CGPA.

B.TECH. ROBOTICS AND ARTIFICIAL INTELLIGENCE

(I-VIII SEMESTER)

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD
SCHEME OF STUDIES & EXAMINATIONS
B.TECH. 1st YEAR (SEMESTER – I)
ROBOTICS AND ARTIFICIAL INTELLIGENCE (2023-24)

Course Code	Course Title	Teaching Schedule				Marks for Sessional	Marks for End Term Examination		Total Marks	Credits	Course Type
		L	T	P	Total		Theory	Practical			
BSC-103RAI	Mathematics- I	3	1	-	4	25	75	-	100	4	BSC
ESC-101A	Basic Electrical Technology	3	1	-	4	25	75	-	100	4	ESC
BSC-102	Chemistry	3	1	-	4	25	75	-	100	4	BSC
HSMC-101	English	2	-	-	2	25	75	-	100	2	HSMC
ESC-107A	Basic Electrical Technology Laboratory	-	-	2	2	15	-	35	50	1	ESC
BSC-105	Chemistry Laboratory	-	-	3	3	15	-	35	50	1.5	BSC
HSMC-102	English Lab	-	-	2	2	15	-	35	50	1	HSMC
ESC-104A/21	Workshop- I	-	-	4	4	30	-	70	100	2	ESC
	Total	**11**	**3**	**11**	**25**	**175**	**300**	**175**	**650**	**19.5**	

Note: Exams Duration will be as under
(a) Theory exams will be of 03 hours duration.
(b) Practical exams will be of 02 hours duration
(c) Workshop exam will be of 03 hours duration

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD
SCHEME OF STUDIES & EXAMINATIONS
B.TECH. 1st YEAR (SEMESTER – II)
ROBOTICS AND ARTIFICIAL INTELLIGENCE (2023-24)

Course Code	Course Title	Teaching Schedule				Marks for Sessional	Marks for End Term Examination		Total Marks	Credits	Course Type
		L	T	P	Total		Theory	Practical			
BSC-101G	Physics (Electromagnetism and Basic Electronics)	3	1	-	4	25	75	-	100	4	BSC
BSC-106RAI	Mathematics- II	3	1	-	4	25	75	-	100	4	BSC
ESC-103	Programming for Problem solving	3	-	-	3	25	75	-	100	3	ESC
MCEVS-01	Environment and Ecology	3	-	-	3	25	75	-	100	3	BSC
BSC-104A	Physics Electromagnetic Lab	-	-	3	3	15	-	35	50	1.5	BSC
ESC-105	Programming for Problem solving Lab	-	-	4	4	15	-	35	50	2	ESC
ESC-102A/21	Engineering Graphics and Drawing	-	-	4	4	30	-	70	100	2	ESC
ESC-106A/21	Workshop- II	-	-	4	4	30	-	70	100	2	ESC
	Total	**12**	**2**	**15**	**29**	**190**	**300**	**210**	**700**	**21.5**	

Note: Exams Duration will be as under
(a) Theory exams will be of 03 hours duration.
(b) Practical exams will be of 02 hours duration
(c) Workshop exam will be of 03 hours duration

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD
SCHEME OF STUDIES & EXAMINATIONS
B.TECH. 2nd YEAR (SEMESTER – III)
ROBOTICS AND ARTIFICIAL INTELLIGENCE (2023-24)

Course Code	Course Title	Teaching Schedule				Marks for Sessional	Marks for End Term Examination		Total Marks	Credits	Course Type
		L	T	P	Total		Theo	Practical			
PCC-RAI-301/21	Materials Engineering	3	1	-	4	25	75	-	100	4	PCC
ESC-303-RAI/21	Engineering Mechanics	3	1	-	4	25	75	-	100	4	ESC
BSC-301-RAI	Mathematics III (Linear Algebra and Numerical Methods)	3	-	-	3	25	75	-	100	3	BSC
PCC-RAI-302/21	Basics of Electronics Engineering	3	-	-	3	25	75	-	100	3	PCC
PCC-RAI-303/21	Data Structure	3	1	-	4	25	75	-	100	4	PCC
PCC-RAI-304/21	Digital Electronics	3	1	-	4	25	75	-	100	4	PCC
BSC-01	Biology	3	-	-	3	25	75	-	100	3	BSC
SEC-RAI-301/21	Project - I	-	-	4	4	30	-	70	100	2	SEC
PCC-RAI-305/21	Basics of Electronics Engineering Lab	-	-	2	2	15	-	35	50	1	PCC
PCC-RAI-306/21	Data Structure Lab	-	-	2	2	15	-	35	50	1	PCC
	Total	**21**	**4**	**8**	**33**	**235**	**525**	**140**	**900**	**29**	

Note: Exams Duration will be as under
(a) Theory exams will be of 03 hours duration.
(b) Practical exams will be of 02 hours duration
(c) Workshop exam will be of 03 hours duration

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD
SCHEME OF STUDIES & EXAMINATIONS
B.TECH. 2nd YEAR (SEMESTER – IV)
ROBOTICS AND ARTIFICIAL INTELLIGENCE (2023-24)

Course Code	Course Title	Teaching Schedule				Marks for Sessional	Marks for End Term Examination		Total Marks	Credits	Course Type
		L	T	P	To		Theory	Practical			
PCC-RAI-401/21	Kinematics of Robots	3	1	-	4	25	75	-	100	4	PCC
PCC- RAI -402/21	Artificial Intelligence	3	-	-	3	25	75	-	100	3	PCC
PCC-RAI-403/21	Design of Machine Elements	3	-	-	3	25	75	-	100	3	PCC
PCC-RAI-404/21	Microprocessor & Microcontroller	3	-	-	3	25	75	-	100	3	PCC
PCC-RAI-405/21	Mechatronics System Design	3	-	-	3	25	75	-	100	3	PCC
MCEVS-02	National Resources and Biodiversity	3	-	-	3	25	75	-	100	3	BSC
MC- 02	Essence of Indian Traditional Knowledge	2	-	-	2	25*	75*	-	-	-	MAC
SEC-RAI-401/21	Project - II	-	-	4	4	30	-	70	100	2	SEC
PCC-RAI-406/21	Artificial Intelligence Lab	-	-	2	2	15	-	35	50	1	PCC
PCC-RAI-407/21	Microprocessor & Microcontroller Lab	-	-	2	2	15	-	35	50	1	PCC
PCC-RAI-408/21	Kinematics of Robots Lab	-	-	2	2	15	-	35	50	1	PCC
	Total	**20**	**1**	**10**	**31**	**225**	**450**	**175**	**850**	**24**	

Note: Exams Duration will be as under

(a) Theory exams will be of 03 hours duration.
(b) Practical exams will be of 02 hours duration
(c) Workshop exam will be of 03 hours duration
(d) * Audit course; Marks and Credits are not to be counted but course is mandatory to pass.

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD
SCHEME OF STUDIES & EXAMINATIONS
B.TECH. 3rd YEAR (SEMESTER – V)
ROBOTICS AND ARTIFICIAL INTELLIGENCE (2023-24)

Course Code	Course Title	Teaching Schedule				Marks for Sessionals	Marks for End Term Examination		Total Marks	Credits	Course Type
		L	T	P	Total		Theory	Practic			
PCC-RAI-501/21	CAD/ CAM	3	-	-	3	25	75	-	100	3	PCC
PCC- RAI -502/21	Digital Signal Processing	3	-	-	3	25	75	-	100	3	PCC
PCC- RAI -503/21	Machine Learning and Application	3	-	-	3	25	75	-	100	3	PCC
	Open Elective Course -I	3	-	-	3	25	75	-	100	3	PCC
BSC-501-RAI	Probability and Statistics	3	1	-	4	25	75	-	100	4	BSC
PCC- RAI -504/21	Communication Systems	3	-	-	3	25	75	-	100	3	PCC
SEC-RAI-501/21	Project - III	-	-	4	4	30	-	70	100	2	SEC
PCC- RAI -505/21	Design and Fabrication Lab	-	-	2	2	15	-	35	50	1	PCC
PCC- RAI -506/21	Python Programming Lab	-	-	2	2	15	-	35	50	1	PCC
	Total	**18**	**1**	**8**	**27**	**210**	**450**	**140**	**800**	**23**	

Note: Exams duration will be as under
(a) Theory exams will be of 03 hours duration.
(b) Practical exams will be of 02 hours duration
(c) Workshop exam will be of 03 hours duration

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD
SCHEME OF STUDIES & EXAMINATIONS
B.TECH 3rd YEAR (SEMESTER – VI)
ROBOTICS AND ARTIFICIAL INTELLIGENCE (2023-24)

Course Code	Course Title	Teaching Schedule				Marks for Sessionals	Marks for End Term Examination		Total Marks	Credits	Course Type
		L	T	P	Total		Theory	Practical			
PCC-RAI-601/21	Introduction to IOT	3	-	-	3	25	75	-	100	3	PCC
PCC-RAI-602/21	Control Systems	3	-	-	3	25	75	-	100	3	PCC
PCC-RAI-603/21	Soft Computing	3	-	-	3	25	75	-	100	3	PCC
	Programme Elective Course- I	3	-	-	3	25	75	-	100	3	PEC
	Programme Elective Course-II	3	-	-	3	25	75	-	100	3	PEC
	Open Elective Course -II	3	-	-	3	25	75	-	100	3	OEC
MCEVS-03	Environment Pollution, Waste Management and Sanitation	3	-	-	3	25	75	-	100	3	BSC
MC-04G	Message of Bhagavad Gita *	2	-	-	2	25*	75*	-	-	-	MAC
SEC-RAI-601/21	Project - IV	-	-	4	4	30	-	70	100	2	SEC
PCC-RAI-604/21	IOT Lab	-	-	2	2	15	-	35	50	1	PCC
PCC-RAI-605/21	Control Systems Lab	-	-	2	2	15	-	35	50	1	PCC
	Total	**23**	**-**	**8**	**31**	**235**	**525**	**140**	**900**	**25**	

Note: Exams Duration will be as under

(a) Theory exams will be of 03 hours duration.
(b) Practical exams will be of 02 hours duration
(c) Workshop exam will be of 03 hours duration

(d) *Audit course; Marks and Credits are not to be counted but course is mandatory to pass

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD
SCHEME OF STUDIES & EXAMINATIONS
B.TECH 4th YEAR (SEMESTER – VII)
ROBOTICS AND ARTIFICIAL INTELLIGENCE (2023-24)

Course Code	Course Title	Teaching Schedule				Marks for Sessionals	Marks for End Term Examination		Total Marks	Credits	Course Type
		L	T	P	Total		Theory	Practical			
PCC-RAI-701/21	Additive Manufacturing	3	-	-	3	25	75	-	100	3	PCC
PCC-RAI-702/21	Deep Learning: Principles and Practices	3	-	-	3	25	75	-	100	3	PCC
PCC-RAI-703/21	Mechanical Vibrations	3	-	-	3	25	75	-	100	3	PCC
	Programme Elective Course-III	3	-	-	3	25	75	-	100	3	PEC
	Programme Elective Course-IV	3	-	-	3	25	75	-	100	3	PEC
	Programme Elective Course-V	3	-	-	3	25	75	-	100	3	PEC
	Open Elective-III	3	-	-	3	25	75	-	100	3	OEC
PCC-RAI-704/21	Additive Manufacturing Lab	-	-	2	2	15	-	35	50	1	PCC
SEC-RAI-701/21	Project - V	-	-	4	4	30	-	70	100	2	SEC
	Total	**21**	**-**	**6**	**27**	**220**	**525**	**105**	**850**	**24**	

Note: Exams Duration will be as under
(a) Theory exams will be of 03 hours duration.
(b) Practical exams will be of 02 hours duration
(c) Workshop exam will be of 03 hours duration

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD
SCHEME OF STUDIES & EXAMINATIONS
B.TECH. 4th YEAR (SEMESTER – VIII)
ROBOTICS AND ARTIFICIAL INTELLIGENCE (2023-24)
Credits: 10 (SEC)

S. No.	Course Code	Title	Schedule	Credits	Examination Schedule (Marks)		
					Annual Exam	Continuous Assessment	Total
1.	SEC-RAI-801/21	Industrial Training	One Semester	10	350	150	500

Procedure for Annual Exam and Continuous Assessment of Industrial Training:

(A) Annual Exams Marks

1. Training Evaluation 100 Marks
2. Training Seminar 100 Marks
3. Training Viva 150 Marks

(B) Continuous Assessment Marks

1. Assessment by University / Institute Faculty 50 Marks
2. Assessment by Industrial Guide 50 Marks
3. Conduct Marks 50 Marks

Total: 500 Marks

BSC-103 RAI MATHEMATICS I

B. Tech (Robotics and Artificial Intelligence) I Semester

No. of Credits: 4	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 1 0 4	Total: 100 Marks
	Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Mathematics II

Course Objectives:

The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate calculus and linear algebra. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Course Outcomes (COs): At the end of the course, the student shall be able to:

- **CO1-** To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
- **CO2-** The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
- **CO3-** The tool of power series and Fourier series for learning advanced Engineering Mathematics.
- **CO4-** To deal with functions of several variables that are essential in most branches of engineering.
- **CO5-** The essential tool of matrices and linear algebra in a comprehensive manner.

Course Contents:

Unit 1

Calculus (Integration): Curvature, radius of curvature, evolutes and involutes. Evaluation of definite and Improper integrals. Beta and Gamma functions and their properties. (6)

Unit 2

Calculus (Differentiation): Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima. (6)

Unit 3

Sequence and Series: Convergence of sequences and series, test for convergence; Power series, Taylor series, Fourier series: Half range sine and cosine series. (13)

Unit 4

Multivariable Calculus: Functions of several variables: Limit, continuity and differentiability, partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers. (10)

Unit 5

Matrices: Matrices: Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Properties of Eigen values and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem. (7)

Recommended/ Reference Books

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, New Delhi.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11 th Reprint, 2010.
5. D. Poole, Linear Algebra: A Modern Introduction, Brooks/Cole.
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications Pvt. Ltd, New Delhi, 7th Edition, 2010.
7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 41 st Edition, 2011.
8. P. Sivaramakrishna Das and C. Vijayakumari, Mathematics-I, Pearson Publisher, 2019.

ESC-101A BASIC ELECTRICAL TECHNOLOGY

B. Tech (Robotics and Artificial Intelligence) I Semester

No. of Credits: 4	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 1 0 4	Total: 100 Marks
	Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Basic Electronics Engineering

Course Objectives:

The objective of this course is to familiarize the prospective engineers with different electrical concepts of AC and DC and its applications.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO1- Analyze and solve D. C. networks by different analysis methods and theorems.

CO2- Formulate and solve complex AC single phase and three circuits.

CO3- Identify the type of electrical machines and their applications.

CO4- Introduce the components of low voltage electrical installations.

Course Contents:

Unit 1

DC Circuits: Basic definitions, Electrical circuit elements (R, L and C), voltage and current sources, Ohm's law and its limitations, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation by mesh analysis and node analysis, Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems. **(10)**

Unit 2

AC Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. **(10)**

Unit 3

Poly Phase Systems: Advantages of 3-phase systems, generation of 3-phase voltages, three phase connections (star and delta), voltage and current relations in star and delta connections, three phase powers, analysis of 3-phase balanced circuits, measurement of 3-phase power- 2 wattmeter method. **(7)**

Unit 4

Transformers: Magnetic Circuits, construction and working of single phase transformer, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency, Auto-transformer **(7)**

Unit 5

Electrical Machines: *Induction motor***:** Construction, principle and working of a three-phase induction motor, Single-phase induction motor: Construction, principle and working, Applications

*DC machine***:** Construction, principle and working of dc motor and generator. Applications

*Synchronous Machine***:** Construction, principle and working of synchronous motor and generators. Applications. **(9)**

Unit 6

Electrical Installations: Components of LT Switchgear: Fuses, MCB, ELCB, MCCB, Types of Wires, Earthing, Power factor improvement. **(7)**

Recommended/ Reference Books:

1. D. P. Kothari and, I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press.
4. E. Hughes, "Electrical and Electronics Technology", Pearson.
5. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India.

Web Links:

1. **NPTL Web Course, Basic Electrical Technology,** Prof. G. D. Roy, Prof. N. K. De, Prof. T.K. Bhattacharya, IIT Kharagpur
(https://nptel.ac.in/courses/108/105/108105053/)

2. **NPTL Web Course, Electrical Machines-I,** Prof. P. Sasidhara Rao, Prof. G. Sridhara Rao, Dr. Krishna Vasudevan, IIT Madras
(https://nptel.ac.in/courses/108/106/108106071/)

3. **NPTL Web Course, Electrical Machines-II,** Prof. P. Sasidhara Rao, Prof. G. Sridhara Rao, Dr. Krishna Vasudevan, IIT Madras
https://nptel.ac.in/courses/108/106/108106072/

BSC-102 CHEMISTRY
(Concepts in Chemistry for Engineering)
B. Tech (Robotics and Artificial Intelligence) I Semester

No. of Credits: 4
L T P Total
3 1 0 4

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Environmental Science

Course Objectives:

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometer levels, one has to base the description of all chemical processes at molecular levels.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO1- Analyze microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.

CO2- Rationalise bulk properties and processes using thermodynamic considerations.

CO3- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.

CO4- Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.

CO5- List major chemical reactions that are used in the synthesis of molecules.

Course Contents:

Unit 1

Atomic and molecular structure: Schrodinger equation. Particle in aboxsolutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transitionmetal ions and their magnetic properties. Band structure of solids and the role of doping on band structures. **(12)**

Unit 2

Spectroscopic techniques and applications: Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering. **(9)**

Unit 3

Intermolecular forces and potential energy surfaces: Ionic, dipolar and vanDer Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H_3, H_2F and HCN and trajectories on these surfaces. **(5)**

Unit 4

Use of free energy in chemical equilibria: Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion.

Use of free energy considerations in metallurgy through Ellingham diagrams. **(8)**

Unit 5

Periodic properties: Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries. **(6)**

Unit 6

Stereochemistry: Representations of 3 dimensional structures, structural isomers and stereo isomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism initransitional metal compounds. **(6)**

Unit 7

Organic reactions and synthesis of a drug molecule: Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule. **(5)**

Recommended/ Reference Books:

1. University Chemistry, by B. H. Mahan.
2. Chemistry: Principles and Applications, by M. J. Sienko and A. Plane.
3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell.

4. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.
5. Physical Chemistry, by P. W. Atkins.
6. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E.Schore.

HSMC-101 ENGLISH

B. Tech (Robotics and Artificial Intelligence) I Semester

No. of Credits: 2
L T P Total
2 0 0 2

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

Course Contents:

Unit 1

Vocabulary Building: The concept of Word Formation; Root words from foreign languages and their use in English; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, antonyms, and standard abbreviations.

Unit 2

Basic Writing Skills: Sentence Structures; Use of phrases and clauses in sentences; Importance of proper punctuation; Creating coherence; Organizing principles of paragraphs in documents; Techniques for writing precisely.

Unit 3

Identifying Common Errors in Writing: Subject-verb agreement; Noun-pronoun agreement;

Misplaced modifiers; Articles; Prepositions; Redundancies; Clichés.

Unit 4

Nature and Style of sensible Writing: Describing; Defining; Classifying; Providing examples or evidence.

Unit 5

Writing introduction and conclusion

Unit 6

Writing Practices: Comprehension; Précis Writing; Essay Writing.

ESC-107A BASIC ELECTRICAL TECHNOLOGY LABORATORY

B. Tech (Robotics and Artificial Intelligence) I Semester

No. of Credits: 1
L T P Total
0 0 2 2

Sessional: 15 Marks
Practical: 35 Marks
Total: 50 Marks
Duration of Exam: 2 Hours

Pre- Requisite: Basic Electrical Technology

Successive: Nil

Course Objectives:

The objective of this course is to familiarize the prospective engineers with practical aspects of different electrical concepts of AC and DC circuits.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO1- Get an exposure to common electrical components and their ratings.

CO2- Make electrical connections by wires of appropriate ratings.

CO3- Understand the usage of common electrical measuring instruments.

CO4- Understand the basic characteristics of transformers and electrical machines.

CO5- Get an exposure to the working of power electronic converters.

List of Experiments/ Demonstrations:

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.

2. Verification of network theorem in DC circuits, Thevenin's Theorem, Norton's, Theorem, Superposition Theorem etc.

3. Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.

4. Poly phase systems, three phase connections (star and delta), measurement of three phase power.

5. Transformers: Observation of the no-load current waveform on an oscilloscope (non-sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.

6. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.

7. Torque Speed Characteristic of separately excited dc motor.
8. Components of LT switchgear.

BSC-105 CHEMISTRY LABORATORY

B. Tech (Robotics and Artificial Intelligence) I Semester

No. of Credits: 1.5
L T P Total
0 0 3 3

Sessional: 15 Marks
Practical: 35 Marks
Total: 50 Marks
Duration of Exam: 2 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO1- Estimate rate constants of reactions from concentration of reactants/products as a function of time.

CO2- Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water etc.

CO3- Synthesize a small drug molecule and analyze a salt sample.

List of Experiments (Choice of 10-12 from the following):

1. Determination of surface tension and viscosity.
2. Thin layer chromatography.
3. Ion exchange column for removal of hardness of water.
4. Determination of chloride content of water.
5. Colligative properties using freezing point depression.
6. Determination of the rate constant of a reaction.
7. Determination of cell constant and conductance of solutions.
8. Potentiometry-determination of redox potentials and emfs.
9. Synthesis of a polymer/drug.
10. Saponification/ acid value of an oil.
11. Chemical analysis of a salt.

12. Lattice structures and packing of spheres.

13. Models of potential energy surfaces.

14. Chemical oscillations-Iodine clock reaction.

15. Determination of the partition coefficient of a substance between two immiscible liquids.

16. Adsorption of acetic acid by charcoal.

17. Use of the capillary viscosimeters to demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

HSMC-102 ENGLISH LAB

B. Tech (Robotics and Artificial Intelligence) I Semester

No. of Credits: 1
L T P Total
0 0 2 2

Sessional: 15 Marks
Practical: 35 Marks
Total: 50 Marks
Duration of Exam: 2 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

List:

1. Listening Comprehension.
2. Pronunciation, Intonation, Stress and Rhythm.
3. Common Everyday Situations: Conversations and Dialogues.
4. Communication at Workplace.
5. Interviews.
6. Formal Presentations.

Recommended/ Reference Books:

1. Practical English Usage. Michael Swan.OUP.
2. Remedial English Grammar. F. T. Wood. acmillan.
3. On Writing Well. William Zinsser. Harper Resource Book.
4. Study Writing. Liz Hamp- Lyons and Ben Heasly. Cambridge University Press.
5. Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press.
6. Exercises in Spoken English. Parts. I- III CIEFL, Hyderabad. Oxford University Press.

ESC-104A/21 WORKSHOP-I

B. Tech (Robotics and Artificial Intelligence) I Semester

No. of Credits: 2		Sessional:	30Marks
L T P Total		Practical:	70 Marks
0 0 4 4		Total :	100Marks
		Duration of Exam:	3Hours

Pre- Requisite: Nil

Successive: Workshop- II, Workshop- III, Workshop- IV, Workshop- V, Workshop- VI, Workshop- VII

PART-A

Computer Engineering Workshop

Course Outcomes (COs): After the completion of the course the student will be able to:

CO1- Acquire skills in basic engineering practice.

CO2- Have working knowledge of various equipment's used in workshop.

CO3- Have hands on experience about various machines and their components.

CO4- Obtain practical skills of basic operation and working of tools used in the workshop.

List of Exercises:

1. To study and demonstrate Block diagram of Digital Computer System and explanation of each unit.
2. To study and demonstrate internal parts of a Computer System (Card level) and other peripheral devices and explanation of POST & BIOS.
3. To study and demonstrate primary memory and secondary memory.
4. To demonstrate Mother Board/ Main Board and its parts, Chipset, Connectors, Add On Card.
5. To study various processor (Pentium-I, II, III, DUAL Core, i-3, i-5, i-7 etc).
6. To study various types of monitors: LCD /LED/TFT/PLASMA DISPLAY& New Technologies
7. To study different printer types and their working.
8. Assembly / Installation and Maintenance of Personnel Computer Systems: Practical exercise on assembly of Personnel Computer System, Installation of Operating System: Windows & Linux etc, Installation of other Application

Softwares and Utility Softwares, Fault finding in Personnel Computers: Software or Hardware wise, Virus: Introduction, its Types & Removal techniques, Data Backup and Restore, Data Recovery Concepts, Typical causes of Data loss

9. Introduction to computer networking concepts: Introduction of Connecting devices: Hub, Switch & Router etc, Networking Cable preparation: Normal & Cross Cables, Data Transferring Techniques from one Computer System to another Computer System, Configuration of Switch/ Routers etc.
10. Introduction to system security and network security.

PART-B
Electrical Workshop

List of Exercises:

1. Introduction of Electrical Safety precautions, Electrical Symbols, Electrical Materials, abbreviations commonly used in Electrical Engg. and familiarization with tools used in Electrical Works.
2. To make a Straight Joint & Tee joint on 7/22 PVC wire and Britannia Joint on GI wire.
3. To study fluorescent Tube Light, Sodium Lamp and High Pressure Mercury Vapour Lamp.
4. To study different types of earthing and protection devices e.g. MCBs, ELCBs and fuses.
5. To study different types of domestic and industrial wiring and wire up a circuit used for Stair case and Godown wiring.
6. To make the connection of fan regulator with lamp to study the effect of increasing and decreasing resistance in steps on the lamp.
7. To fabricate half wave and full wave rectifiers with filters on PCB.
8. Maintenance and Repair of Electrical equipment i,e Electric Iron , Electric Toaster ,Water heater, Air coolers and Electric Fans etc.
9. To study soldering process with simple soldering exercises.
10. To make the connection of a three core cable to three pin power plug and connect the other cable end by secured eyes connection using

23/0.0076”or 40/0.0076”cable.

PART- C
Electronics Workshop

List of Exercises:

1. To study and demonstrate basic electronic components, Diode, Transistor, Resistance, Inductor and capacitor.

2. To study and demonstrate resistance color coding, measurement using color code and multimeter and error calculation considering tolerance of resistance.

3. To study and demonstrate multimeter and CRO- front panel controls, description of block diagram of CRT and block diagram of CRO.

4. To study and demonstrate Vp (peak voltage),Vpp (peak to peak voltage), Time, frequency and phase using CRO.

5. Introduction to function generator. Functions of front panel controls and measurement of different functions on CRO.

6. To study and demonstrate variable DC regulated power supply, function of controls and DC measurement using multimeter and CRO.

7. Soldering practice on wire mesh or a resistance decade board includes fabrication, soldering, lacing, harnessing forming and observation.

8. Testing of components using multimeter and CRO like diode, transistor, resistance capacitor, Zener diode and LED.

9. To study and demonstrate rectification, half wave, Full wave and bridge rectifier. Fabrication, assembly and wave form observation.

10. To design and fabricate a printed circuit board of a Zener regulated/ series regulated power supply and various measurements, testing of power supply.

Note: At least 8 exercises are to be performed from each part by the students.

BSC-101G PHYSICS
(Electromagnetism and Basic Electronics)
B. Tech (Robotics and Artificial Intelligence) II Semester

No. of Credits: 4
L T P Total
3 1 0 4

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objective:

The objective of studying this course is to understand and apply the concepts of electromagnetism and electronics in the applications of Robotics and Artificial Intelligence.

Course Outcomes (COs): After the completion of this course, the learner will be able to:

CO1- Learn the fundamentals of electrostatics and magnetostatics.

CO2- Understand the basics of analog and digital electronics.

CO3- Verify the energy conservation law for electromagnetic waves using the principles of electromagnetism.

CO4- Differentiate the analog and digital electronics by portraying the basic circuits involved and their applications.

CO5- Apply the basics of digital electronics to simple binary operations like addition and subtraction.

CO6- Identify the current flow mechanisms and gains in semiconductor diodes and transistors.

Course Contents:

Unit 1
Electrostatics and Magnetostatics:
Electric field and Electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Gauss's law, Electric potential, Laplace's and Poisson's equations for Electrostatic potential, Applications of Gauss's law, Energy of a charge distribution and its expression in terms of electric field, Bio-Savart law, Differential Equations of Magnetostatics and Ampere's Law; Applications of Ampere's law, Magnetic Vector Potential. **(12)**

Unit 2 Electromagnetic induction and Maxwell's equations:
Motional EMF, Faraday's Law of magnetic induction. Lenz's law. Continuity equation for current densities; Inductance, Self and Mutual inductance, Self inductance and mutual inductance in an inductor and a solenoid, Energy in the Magnetic Field, Maxwell's

equations, Displacement current, Maxwell's equation in vacuum and non-conducting medium. **(12)**

Unit 3 Analog Electronics:

P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. Barrier Formation in PN Junction Diode. Current Flow Mechanism in Forward and Reverse Biased Diode. Zener Diode and Voltage Regulation, n-pn and p-n-p Transistors. I-V characteristics of CB and CE Configurations. Active, Cut off and Saturation Regions. Current gains α and β. Relations between α and β. **(12)**

Unit 4 Digital Electronics:

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates. De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. **(12)**

Text Books:

1. David Griffiths, Introduction to Electrodynamics.
2. Venugopal, Digital Circuits and systems.
3. J.D. Ryder, Electronics: Fundamentals and Applications.

Reference Books:

1. Halliday and Resnick, Physics.
2. W. Saslow, Electricity, magnetism and light.
3. A.P.Malvino, D.P. Leach and Saha, Digital Principles and Applications.
4. S.Salivahanan & N.S.Kumar, Electronic Devices & circuits.
5. S.M. Sze, Semiconductor Devices: Physics and Technology.

BSC-106 RAI MATHEMATICS II

B. Tech (Robotics and Artificial Intelligence) II Semester

No. of Credits: 4	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 1 0 4	Total: 100 Marks
	Duration of Exam: 3 Hours

Pre- Requisite: Mathematics I

Successive: Nil

Course Objectives:

The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary differential equations. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

Course Outcomes (COs): At the end of the course, the student will learn:

CO1- The mathematical tools needed in evaluating multiple integrals and their usage.

CO2- The effective mathematical tools for the solutions of differential equations that model physical processes.

CO3- Basics concepts of Complex Analysis.

CO4- Different tools of differentiation.

CO5-Integration of functions of a complex variable that are used with various other techniques for solving engineering problems.

Course Contents:

Unit 1

Multiple integrals and Applications: Multiple Integration, Change of variables in double integrals (Cartesian to polar), Applications: areas and volumes;/; Triple integrals (Cartesian), Scalar line integrals, Gradient, Curl and Divergence, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes. (11)

Unit 2

First order ordinary differential equations: Exact equations, Rules for finding the integrating factor for Non-Exact Differential Equation Mdx+Ndy=0, linear and Bernoulli's equations. Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type. (5)

Unit 3

Differential equations (Higher order): Linear differential equations of higher order-with constant coefficients. The operator D, Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Simultaneous linear differential equations. (9)

Unit 4

Complex Variable (Differentiation): Differentiation of complex functions, Cauchy-Riemann equations, Analytic functions, Harmonic functions, determination of harmonic conjugate, elementary analytic functions (exponential, trigonometric, logarithmic). (10)

Unit 5

Complex Variable (Integration): Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville's theorem (without proof), Taylor's series, Zeros of analytic functions, Singularities, Laurent's series; Residues, Cauchy residue theorem (without proof), Evaluation of definite integral involving sine and cosine. (8)

Recommended/ Reference Books

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, New Delh, 8th Edition.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5. P. Sivaramakrishna Das and C. Vijayakumari, Mathematics-I, Pearson Publisher, 2019.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2014.
7. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
8. E. L. Ince, Ordinary Differential Equations, Dover Publications.
9. J. W. Brown and R. V. Churchill, Complex Variables and Applications, Mc-GrawHill.

ESC- 103 PROGRAMMING FOR PROBLEM SOLVING

B. Tech (Robotics and Artificial Intelligence) II Semester

No. of Credits: 3
L T P Total
3 0 0 0

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Outcomes (COs): At the end of the course, the student will learn:

CO1- To formulate simple algorithms for arithmetic and logical problems.

CO2- To implement conditional branching, iteration and recursion.

CO3- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.

CO4- To use arrays, pointers and structures and apply programming to solve simple numerical method problems, namely root finding of function, differentiation of function and simple integration.

Course Contents:

Unit 1

Introduction to Programming: (4)

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.). **(1)**

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/ Pseudo code with examples. (**1)**

From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code. **(2)**

Unit 2

Arithmetic expressions and precedence **(2)**

Conditional Branching and Loops **(6)**

Writing and evaluation of conditionals and consequent branching **(3)**

Iteration and loops **(3)**

Unit 3

Arrays: Arrays (1-D, 2-D), Character arrays and Strings **(6)**

Unit 4

Basic Algorithms: Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required). **(6)**

Unit 5

Function: Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference **(5)**

Unit 6

Recursion: Recursion, as a different way of solving problems. Example Programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort. **(4-5)**

Unit 7

Structure: Structures, Defining structures and Array of Structures. **(4)**

Unit 8

Pointers

Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation). **(2)**

Unit 9

File handling (only if time is available, otherwise should be done as part of the lab)

Recommended/ Reference Books:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2. E. Balaguruswamy, Programming in ANSIC, Tata Mc Graw-Hill.
3. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall.

MCEVS-01 ENVIRONMENT AND ECOLOGY

B. Tech (Robotics and Artificial Intelligence) II Semester

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Outcomes (COs): At the completion of this course, the learner will be able to:

CO1- Demonstrate knowledge of basics related to Environment and its components.

CO2- Understand the concepts of population ecology and human population

CO3- Analyze components of ecosystems and compare them with real life processes.

CO4- Interpret ecological phenomena of different ecosystems.

Course Contents:

Unit 1

Introduction to Environmental Studies: Definition and Components of Environment, Relationship between the different components of Environment. Concept of biosphere, Atmosphere, lithosphere and hydrosphere;Components of atmosphere, Man and Environment Relationship, Impact of technology on Environment.

The Multidisciplinary nature of environmental studies. Definition; Scope and importance, need for public awareness.

Unit 2

Human population and Environment: Population growth, vanat1on among nations. Population explosion -Causes, Effects and Control, Family welfare programme. Human right. Value Education, Women and Child Welfare.

Population Interactions and Adaptations: Neutralism; positive interactions-commensalism, proto cooperation, mutualism and symbiosis; negative interactions-competition, predation and parasitism; importance of negative interactions. Invasive species and pest control.

Unit 3

Concept of Ecosystem: Concept of an ecosystem. Definition, scope and significance of Ecology, Concept of habitat and ecological niche, Structure and function of an

Ecosystem.Producers. Consumers and decomposers. Energy flow in the ecosystem. Ecological succession.

Food chairs, food web and ecological pyramids.

Unit 4

Biomes: Concept; major biomes of the world; Introduction, types, characteristic features, structure and function of the following ecosystems: - Forest ecosystem Grassland ecosystem, Desert ecosystem and Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Reference Books:

1. Brewer, R. The Science of Ecology, Sanders College Publishing Co.,Tokyo, 1994.
2. Odum, E. P. Basic Ecology, W.B. Saunders, Philadelphia, 1983.
3. Jorgensen, Sven Erik. Encyclopedia of' Ecology. Vol 1-5. Elsevier Publishers. Netherlands, 2008.
4. Kohli, R. K., Jose, S., Singh, 1--1. P. and Batish, D. R. invasive Plants and Forest Ecosystems. CRC Press / Taylor and Francis, 2009.
5. Odum, E.P., Barrick, M. and Barrett, G. W. Fundamentals of Ecology (5th Ed). Thomson Brooks/Cole Publisher, California, 2005.
6. Rana, S.V.S. Essentials of Ecology and Environmental Science (5th Ed), PHI Learning Pvt. Ltd, 2013 .
7. Sharma, P.O. Ecology and Environment. Rastogi Publications. New Delhi, 20I6.
8. Smith, R.L. (1996), Ecology and Field Biolog·y, Harper Collins, New York.
9. Smith, T.M and Smith, R.L. Elements of Ecology (8th Ed), Benjamin Cummings, 2012.
10. Vandermeer, John H., Riddle, B.R. and Brown, J.H. Population Ecology: First principle (2nd Ed). Princeton University Press, 2013.
11. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). Ecology, Environment and Resource Conservation, S. Chand Publishing, New Delhi.

Suggested Web Sources:

1. http: //cnvisnic.in/l :NVIS html/l_NVISSubjcct/s ubjcct.html

2 https://nptel.ac.in/courses/103/106/103106162/

3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14

4. https://swayam.gov.in/

BSC-104A PHYSICS ELECTROMAGNETIC LAB

B. Tech (Robotics and Artificial Intelligence) II Semester

No. of Credits: 1.5	Sessional: 15 Marks
L T P Total	Practical: 35 Marks
0 0 3 0	Total: 50 Marks
	Duration of Exam: 2 Hours

List of Experiments:

At least 06 experiments from the following

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan`s law of radiation and to determine Stefan's constant.
12. To determine Boltzmann constant using V-I characteristics of PN junction diode.

Note: Experiments may be added or deleted as per the availability of equipments.

Recommended/ Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, Heinemann Educational Publishers.
3. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, Springer.

ESC- 105 PROGRAMMING FOR PROBLEM SOLVING LAB

B. Tech (Robotics and Artificial Intelligence) II Semester

No. of Credits: 2	Sessional: 15 Marks
L T P Total	Practical: 35 Marks
0 0 4 4	Total: 50 Marks
	Duration of Exam: 2 Hours

Course Outcomes (COs): At the end of the course, the student will learn:

CO-1 To formulate the algorithms for simple problems.

CO2- To translate given algorithms to a working and correct program.

CO3- To be able to correct syntax errors as reported by the compilers.

CO4-To be able to identify and correct logical errors encountered at run time.

CO5- To be able to write iterative as well as recursive programs.

CO6- To be able to represent data in arrays, strings and structures and manipulate them through a program.

CO7- To be able to declare pointers of different types and use them in defining self-referential structures.

CO8- To be able to create, read and write to and from simple text files.

Tutorial 1: Problem solving using computers:

Lab 1: Familiarization with programming environment.

Tutorial 2: Variable types and type conversions:

Lab 2: Simple computational problems using arithmetic expressions.

Tutorial 3: Branching and logical expressions:

Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:

Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1 D Arrays: searching, sorting:

Lab 5: 1 D Array manipulation

Tutorial 6: 2 D arrays and Strings

Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:

Lab 7: Simple functions

Tutorial 8 & 9: Numerical methods (Root finding, numerical differentiation, numerical integration):

Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls

Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation

Lab 11: Pointers and structures

Tutorial 12: File handling:

Lab 12: File operations

ESC- 102A/21 ENGINEERING GRAPHICS AND DRAWING

B. Tech (Robotics and Artificial Intelligence) II Semester

No. of Credits: 2
L T P Total
0 0 4 4

Sessional: 30 Marks
Practical: 70 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: CAD/CAM

Course Objectives:

The objective of studying this course is to understand the basic principles of engineering drawing and graphics and to apply the same to daw different types of projections.

Course Outcomes: At the end of the course, the student shall be able to:

CO 1- Understand the basic principles of projections of points and lines.

CO 2- Know the different orientations and projections of planes and solids.

CO 3- Learn about the projections of sectioning of solids in different orientations and development of surfaces.

CO 4- Draw orthographic and isometric view of an object.

CO 5- Learn about the basics of AUTOCAD

Course Contents:

Unit 1

Introduction: Importance, Significance and scope of Engineering Drawing, Usage of drawing Instruments, Dimensioning, Scales, Sense of proportioning, Different types of projections, Orthographic projections of simple engineering objects, B.I.S Specifications. **(12)**

Unit 2

Projection of Points & Lines: Introduction of plane of projection, reference & auxiliary planes, projection of points and line in different quadrants, traces, inclinations & true lengths of the lines, projections on auxiliary plane, shortest distance intersecting and non intersecting lines. **(8)**

Unit 3

Projection of Planes and Solids: Parallel to one reference plane, inclined to one plane but perpendicular to the other, inclined to both reference planes. Projection of Polyhedra, solids

of revolution-in simple positions with axis perpendicular to a plane, with axis parallel to both planes, with axis parallel to one plane and inclined to the other. **(8)**

Unit 4

Sectioning of Solids and Development of Surfaces: Projections of sections of prisms, pyramids, cylinders and cones. Development of simple object with and without sectioning. **(4)**

Unit 5

Isometric Projections: Introduction, isometric scale, Isometric view of plane figures, prisms, pyramids and cylinders. **(4)**

Unit 6

Overview of Computer Graphics: Introduction to AUTOCAD and practice of simple exercises related to the above units on CAD Software. **(8)**

Recommended/ Reference Books:

1. Machine Drawing - N D Bhatt and V M Panchal, Charotar Publishing House.

2. A Text Book of Machine Drawing - P S Gill Pub.: S K Kataria & Sons.

3. A Text Book of Engineering Drawing and Machine Drawing by M. L. Aggarwal and Sandhya Dixit: Dhanpat Rai & Co.

4. Textbook on Engineering Drawing, K. L. Narayana and P. Kannaiah, Scitech Publishers

Web Links:

S.N	Address of web source	Content
1.	https://youtu.be/2C8H2rIwhrA	Engineering Drawing
2.	https://youtu.be/xzi_R8lims0	Drawing Layouts

ESC-106A/21 WORK SHOP-II

B. Tech (Robotics and Artificial Intelligence) II Semester

MECHANICAL ENGINEERING WORKSHOP

No. of Credits: 2		Sessional:	30Marks
L T P Total		Practical:	70 Marks
0 0 4 4		Total :	100Marks
		Duration of Exam:	3 Hours

Pre- Requisite: Workshop -I

Successive: Workshop- III, Workshop- IV, Workshop- V, Workshop- VI, Workshop- VII

Course Outcomes (COs): After studying this course the students will be able to:

CO 1- Acquire skills on basic engineering materials and safety aspects.

CO 2- Understand the fundamental concept of various basic engineering practices namely fitting, sheet metal, carpentry, pattern making and welding etc.

CO 3- Learn and use different marking & measuring instruments used in machine shop, fitting shop, sheet metal shop, carpentry & pattern making shop etc.

CO 4- Practice real time job preparation using various operations related to fitting, sheet metal, carpentry, welding & foundry etc.

List of Exercises:

Machine shop, fitting shop, sheet metal shop, carpentry & pattern making shop, welding shop, foundry shop, forging (smith) shop and injection moulding shop.

Section (A): Machine Shop

1. To understand the layout, safety measures and fundamental concept of different engineering materials used in the workshop.
2. To study and demonstrate the various parts, specifications & operations on lathe, milling and shaping machine.
3. To study different types of measuring tools used in metrology and determine the least count of vernier calipers, vernier height gauges and micrometers.

Section (B): Fitting & Sheet Metal Shop

4. To study different types of tools, equipments, devices and machines used in fitting shop.
5. To prepare a job involving filing, drilling, tapping and hacksaw cutting operations on mild steel plate.
6. To study various types of sheet metal tools and prepare a simple sheet metal joint.

Section (C): Carpentry and Pattern Making Shop

7. To study various types of carpentry and pattern making tools and equipments.
8. To prepare a simple wooden joint (cross lap / Tee-lap/dovetail joint) using kail wood in carpentry shop.
9. To prepare single piece pattern / split pattern using kail wood in pattern making shop.

Section (D): Welding Shop

10. To practice striking an arc and prepare straight short bead on given M.S. plate in flat position by arc welding.
11. To prepare straight continuous bead and re start of electrode in flat position by arc welding on given M.S. plate as per size.
12. To practice tack weld &close butt joint in flat position by arc welding on given M.S. plate as per size.

Section (E): Foundry, Forging (Smithy) & Injection Moulding shop

13. To study various types of foundry tools and prepare a mould cavity using single/split pattern in moulding sand.
14. To study various types of forging / black smithy tools and prepare a ring or hook by hand forging operation.
15. To study the working of injection molding machine and prepare a simple component by injection moulding.

NOTE: - Total twelve exercises should be performed from the above list. At least two from each section and remaining two may either be performed from above list or designed by the concerned institution as per the scope of the syllabus and facilities available in institute.

PCC-RAI-301/21 MATERIALS ENGINEERING

B.Tech. (Robotics and Artificial Intelligence) III semester

No. of Credits: 4
L T P Total
3 1 0 4

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Physics, Mathematics II
Successive: Kinetics of Robotics, Design of Machine Elements, Additive Manufacturing

Course Objectives:
The objective of studying this course is to develop understanding of crystallography, mechanisms of deformation & fracture, evaluation of Simple stresses and applications of theories of failure.

Course Outcomes (COs): At the end of the course, the student shall be able to:

- **CO1-** Understand the concept of crystallography and crystal defects.
- **CO2-** Comprehend the deformation and strengthening mechanism in materials.
- **CO3-** Analyse the static stresses and strains within the elementary structural members.
- **CO4-** Describe various fracture modes, mechanisms and factors associated with them.
- **CO5-** Predict behaviour of materials by using various theories of failures.
- **CO6-** Apply their knowledge about the properties and application of advanced engineering materials keeping in view their economic, environmental and societal impact.

Course Contents:

Unit 1
Crystallography and Associated Defects: Introduction to Materials Science and Engineering, Basic concepts of Crystals, Unit Cells, Crystal Systems, Point Coordinates, Crystallographic Directions, Crystallographic Planes, Density Computations, Linear and Planar Densities, Single Crystals and Polycrystalline Materials, Polymorphism and Allotropy, Anisotropy, Non-crystalline solids, Imperfections in Solids, Point Defects, Dislocations, Interfacial Defects, Bulk or Volume Defects. (6)

Unit 2
Deformation and Strengthening Mechanisms in Alloys: Basic Concepts, Characteristics of Dislocations, Slip Systems, Slip in Single Crystals and CRSS, Plastic Deformation of Polycrystalline Materials, Deformation by Twinning, Strengthening of alloys by grain size reduction, solid solution strengthening and strain hardening. (6)

Unit 3

Stress, Strain and Deformation of Solids: Rigid bodies and deformable solids, Tension, Compression and Shear Stresses, Hooke's law, Elastic constants and their relations, Plastic behaviour of materials, Deformation of simple and compound bars, Thermal stresses, Volumetric strains, Stresses on inclined planes, principal stresses and principal planes, Mohr's circle of stress. Numerical Problems. (7)

Unit 4

Fracture in Alloys: Fundamentals of Fracture, Failure vs. Fracture, Ductile Fracture, Brittle Fracture, Principles of Fracture Mechanics, Stress concentration, Fracture toughness, Fatigue, Cyclic Stresses, The S–N Curve, Crack Initiation and Propagation, Factors that affect Fatigue Life, Environmental Effects on fatigue life, Creep in alloys, Generalized Creep Behaviour, Stress and Temperature Effects on creep. (6)

Unit 5

Theories of Elastic Failure: Various theories of elastic failures with derivations and graphical representations, applications to problems of 2-D &3-D stress system with (i) Combined direct loading and bending (ii) combined torsional and direct loading. Numerical Problems (6)

Unit 6

Advanced Engineering Materials: Types and applications of Ceramics, Particle Reinforced Composites, Fiber-Reinforced Composites, Introduction to Nano-materials, Shape-Memory Alloys, Bio-materials, Recyclable polymers and Biodegradable Polymers, Economic, Environmental, and Societal Issues in Materials Engineering, Introduction to RoHS directives.

Recommended/ Reference Books:

1. Material Science and Engineering-An Introduction: Callister, W.D., John Wiley & Sons, Delhi.
2. Elements of Material Science and Engineering: Lawrence H. Van Vlack, Pearson Education India.
3. Introduction to Engineering Materials: B. K. Agarwal, Tata McGraw-Hill Education, India
4. The Essence of Materials for Engineers Robert W., Jr. Messler - Jones and Bartlett Publishers, Inc., USA
5. Engineering Materials: Kenneth G. Budinski, Prentice Hall of India, New Delhi
6. Material Science & Engineering –V. Raghvan, Prentice Hall of India Pvt. Ltd, New Delhi
7. Strength of Materials by G.H.Ryder, Macmillan Publishers India Limited.
8. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi.
9. R. Subramanian, Strength of Materials, Oxford University Press.
10. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi

Related Weblinks for additional information

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://nptel.ac.in/courses/122/102/122102008/
3. https://nptel.ac.in/courses/112/108/112108150/
4. https://nptel.ac.in/courses/112/107/112107146/
5. https://www.youtube.com/watch?v=6CLEWA2WNqM

ESC-303-RAI/21 ENGINEERING MECHANICS

B. Tech. (Robotics and Artificial Intelligence) III Semester

No. of Credits:			4	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	1	0	4	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Physics, Mathematics

Course Objectives:

The objective of this course is to provide an introduction of Engineering Mechanics fundamentals and applications.

Course Outcomes: At the end of the course, the student shall be able to:

- **CO1-** Understand the basic force system and equilibrium.
- **CO2-** Apply principles of friction in engineering problems.
- **CO3-** Understand the concepts of Structure analysis.
- **CO4-** Understand the concepts of Kinematics and Kinetics of Rigid Bodies.

Course Contents:

Unit 1

Force Systems: Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems. (8)

Unit 2

Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indical notation; Symmetric and anti-symmetric tensors; Eigen values and Principal axes. Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors. (5)

Unit 3

Structural Analysis: Equilibrium in three dimensions. Trusses: Method of Sections, Method of Joints, Zero force members. Beams & types of beams, Frames & Machines. (7)

Unit 4

Centroid and Centre of Gravity: Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook. (7)

Unit 5

Particle Dynamics: Rectilinear motion, Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique). (8)

Unit 6

Kinematics and Kinetics of Rigid Bodies: Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D' Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation. (8)

Text Books/ Reference Books:

1. Irving H. Shames, Engineering Mechanics, Prentice Hall
2. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, Tata McGraw Hill
3. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Hibler and Gupta, Engineering Mechanics (Statics, Dynamics) by Pearson Education.
5. Reddy Vijaykumar K. and K. Suresh Kumar, Singer's Engineering Mechanics.
6. Bansal R.K., A Text Book of Engineering Mechanics, Laxmi Publications.

Web Links:

Note: It is recommended that some part of the syllabus is to be covered in online mode.

BSC-301-RAI MATHEMATICS III
(LINEAR ALGEBRA AND NUMERICAL METHODS)
B. Tech. (Robotics and Artificial Intelligence) III Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The objective of this course is to introduce the concepts of vector space, linear transformations and to apply the concept of inner product space in orthogonalization and also familiarize the students with numerical techniques of differentiation and integration.

Course Outcomes: At the end of the course, the student shall be able to:

- **CO1-** Demonstrate accurate and efficient use of advanced algebraic techniques.
- **CO2-** Learn linear Transformations.
- **CO3-** To apply the concept of inner product space in orthogonalization.
- **CO4-** Know about the solution of algebraic and transcendental equations.
- **CO5-** Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.

Course Contents:

Unit 1

Vector Spaces: Vector spaces – Subspaces – Linear combinations and linear system of equations – Linear independence and linear dependence – Bases and dimensions. (8)

Unit 2

Linear Transformation and Inner Product Spaces: Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of a linear transformations - Eigen values and eigenvectors – Diagonalizability, Definition and properties of inner product space, orthogonality, Cauchy Schwarz inequality, Norm and Orthogonal Basis and Gram-Schmidt orthogonalization. (12)

Unit 3

Approximation in numerical computation: Errors in Numerical calculations: Introduction, Numbers and their accuracy, Absolute, relative and percentage errors. Solution of Algebraic and Transcendental Equations: Bisection method, method of false position, secant method, iteration method, Newton's Raphson method. Order of convergence of the above methods. (10)

Unit 4

Finite Differences and Interpolation: Various difference operators and relation between them, Newton's forward and backward interpolation formulae. Central difference interpolation formula. Gauss forward and backward interpolation formulae. Langrage`s interpolation formula and Newton's divided difference formulae. (8)

Unit 5

Solutions of Simultaneous Algebraic Equations and Numerical Differentiation and Integration: Gauss Elimination method, Gauss-Jorden method, LU Decomposition, Jacobi's method, Gauss-Seidel method Formula for derivatives, Trapezoidal rule, Simpson's 1/3rd and 3/8th rules.(6)

Text Books/ Reference Books:

1. Howard Anton and Chris Rorres, Elementary Linear Algebra, John Wiley & Sons, New Delhi, 2011.

2. David C Lay, ―Linear Algebra and its Applications, Pearson Education, New Delhi, 2012.

3. Stephen H Friedberg, Lawrence E Spence, Arnold J Insel, ― Linear Algebra, Pearson, 4th edition, 2015.

4. I. N. Herstein, ―Topics in Algebra, John Wiley & Sons, New Delhi, 2006.

5. Glyn James, David Burely, Phil Dyke, Dick Clements, Nigel Steele, John Searl and Jerry Wright Advanced Modern Engineering Mathematics, Pearson Education, 15th edition 2018.

6. Kolman, B. Hill, D.R., ―Introductory Linear Algebra, Pearson Education, New Delhi, First Reprint, 2009. 7. Kumaresan, S., ―Linear Algebra - A Geometric Approach, Prentice – Hall of India, New Delhi, Reprint, 2010.

8. B.S. Grewal, Numerical Methods in Engg. & Science, Khanna Publications, 2013.

9. S.S. Shastri, Introduction Methods of Numerical Analysis, PHI learning pvt. limited

10. Strang, G., ―Linear Algebra and its applications, Thomson (Brooks/Cole), New Delhi, 4th edition, 2006.

Web Links:

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PCC-RAI-302/21 BASICS OF ELECTRONICS ENGINEERING
B. Tech. (Robotics and Artificial Intelligence) III Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

On successful complete of this course, the students should be able to:

• Understand semiconductor devices like diodes transistor and JFET and their applications.

• Understand the concept of RC coupled amplifier & various classes of power amplifier.

• Understand basic concept of oscillators and circuits of RC phase shift and wein bridge oscillator.

• Understand basics of Operational amplifier and their linear and nonlinear applications.

Course Outcomes: At the end of the course, the student shall be able to:

CO1- To introduce basic concept of diode, transistor and JFET and their applications.

CO2- To introduce the power amplifier and basic concept of R C coupled amplifier.

CO3- To introduce concept of oscillation and various types of oscillators.

CO4- To introduce Operational amplifier and their linear & nonlinear applications.

Course Contents:

Unit 1

Diode Circuits: P-N junction diode, V-I characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits, voltage multiplier circuits.

Unit 2

BJT & Biasing Circuits: Structure and V-I characteristics of a BJT, BJT as an amplifier, common-emitter, common-base and common collector amplifiers; Analysis of transistor amplifier circuits using h parameters. Biasing: operating point, bias stability, stability factor, and different biasing methods.

Unit 3

FET Circuits: Junction field effect transistor, pinch off voltage, V-I characteristics, small signal model, common source amplifier, source follower, biasing of FET, application of FET as VVR.

Unit 4

Multi-Stage and Power Amplifiers: Frequency response of an amplifier, R C coupled amplifier, low frequency response of RC coupled amplifier, various classes of operation (Class A, B, AB, C etc), their power efficiency.

Unit 5

Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (Phase Shift, Wein Bridge), LC oscillators (Hartley, Colpitt, Clapp), non- sinusoidal oscillators.

Unit 6

Operational Amplifier: Ideal and practical operational amplifier, inverting and non-inverting amplifier, differential amplifier, offset error: voltage and current, common mode rejection ratio (CMRR).

Unit 7

Linear & Nonlinear Applications of Op-Amp: Scale changer, phase Shifter, adder, subtractor, integrator, differentiator, comparators, schimitt trigger, zero crossing detector, active filters, precision rectifier.

Text Books/ Reference Books:

1. Integrated Electronics: MilmanHalkias, TMH.
2. Operational Amplifiers: Gaikwad,PHI
3. Electronic Circuit Analysis and Design (Second edition): D.A. Neamen; TMH
4. Integrated Circuits: K R Botkar.
5. Linear Integrated Circuits: D R Chaudhary (WEL).
6. Electronics Devices & Circuits: Boylestad

Web Links:

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PCC-RAI-303/21 DATA STRUCTURE

B. Tech. (Robotics and Artificial Intelligence) III Semester

No. of Credits:			4	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	1	0	4	Total:	100 Marks
				Duration of Exam:	3 Hours

Course Objectives:

The objective of studying this course is:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques
3. To understand basic concepts about stacks, queues, lists, trees and graphs.
4. To enable them to write algorithms for solving problems with the help of fundamental data structures

Course Outcomes: At the end of the course, the student shall be able to:

CO1- For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.

CO2- Student will able to write searching and sorting algorithm compare their performance in term of Space and Time complexity.

CO3- For a given problem of Stacks, Queues, linked list and Tree, student will able to implement it and analyze the same to determine the time and computation complexity.

CO4- Student will able to implement Graph search and traversal algorithms and determine the time and computation complexity.

Course Contents:

Unit 1

Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Techniques and their complexity analysis.

Unit 2

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queues: Simple Queue, Circular Queue, Priority Queue; Operations on each type of Queues: Algorithms and their analysis.

Unit 3

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and

algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees, B Tree, B+ Tree: definitions, algorithms and analysis.

Unit 4

Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods. Hashing and collision resolution. Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Text Books/ Reference Books:

1. A. M. Tenenbaum, Langsam, Moshe J. Augentem, "Data Structures using C," PHI Publication.

2. A.V. Aho, J.E. Hopcroft and T.D. Ullman, "Data Structures and Algorithms" Original edition, Addison-Wesley.

3. Ellis Horowitz & Sartaj Sahni, "Fundamentals of Data structures".

4. https://nptel.ac.in/courses/106102064

PCC-RAI-304/21 DIGITAL ELECTRONICS

B. Tech. (Robotics and Artificial Intelligence) III Semester

No. of Credits:			4	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	1	0	4	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

On successful complete of this course, the students should be able to:

• Acquaint the students with the fundamentals of digital electronics.

• Familiarize the students with design of various combinational circuits.

• Acquaint the students with the design and analysis of various sequential circuits.

• Familiarize the students with logic families and semiconductor memories.

Course Outcomes: At the end of the course, the student shall be able to:

CO1- Understand basic logic gates and digital circuit systems.

CO2- Understand, analyze and design combinational logic circuits.

CO3- Understand digital logic families & semiconductor memories.

CO4- Understand, analyze and design synchronous sequential logic circuits.

Course Contents:

Unit 1

Fundamentals of Digital Systems and Logic Families: Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs.

Unit 2

Combinational Digital Circuits: Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, digital comparator, parity checker/generator, code converters, priority encoders, Q-M method of function realization.

Unit 3

Sequential Circuits and Systems: A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and D types flip flops, applications of flip flops, shift

registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.

Unit 4

A/D and D/A Converters: Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs.

Unit 5

Semiconductor Memories And Programmable Logic Devices: Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

Text Books/ Reference Books:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.

2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.

3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

Web Links:

Note: It is recommended that some part of the syllabus is to be covered in online mode.

BSC 01 BIOLOGY

B. Tech (Robotics and Artificial Intelligence) III Semester

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Environmental Science

Course Objectives:

The objective of this course is to learn the Basic concept of Biology related to Engineers, Genetics, Biomolecules, Enzymes, Information Transfer, Macromolecular analysis, Metabolism, Microbiology

Course Outcomes (COs): After the completion of this course, the students will be able to:

CO1- Classify enzymes and distinguish between different mechanisms of enzyme action.

CO2- Identify DNA as a genetic material in the molecular basis of information transfer.

CO3- Analyze biological processes at the reductionist level

CO4- Apply thermodynamic principles to biological systems.

CO5- Identify and classify microorganisms.

Course Contents:

Unit 1

Introduction: Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.

Unit 2

Classification: Purpose: To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e)

Habitata- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus

Unit 3

Genetics: Purpose: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences" Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring.Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

Unit 4

Biomolecules: Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA.Two carbon units and lipids.

Unit 5

Enzymes: Purpose: To convey that without catalysis life would not have existed on earthEnzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyse reactions. Enzyme classification.Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

Unit 6

Information Transfer: Purpose: The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code.Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.

Unit 7

Macromolecular Analysis: Purpose: How to analyses biological processes at the reductionistic level Proteins- structure and function. Hierarch in protein structure.Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements. **(5)**

Unit 8

Metabolism: Purpose: The fundamental principles of energy transactions are the same in physical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge. **(4)**

Unit 9

Microbiology: Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics. **(3)**

Recommended/ Reference Books:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd.
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons.
3. Principles of Biochemistry, By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company.
4. Molecular Genetics, Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher.
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein Wm, C. Brown Publishers.

PCC-RAI-305/21 BASICS OF ELECTRONICS ENGINEERING LAB

B. Tech. (Robotics and Artificial Intelligence) III Semester

No. of Credits:			1	Sessional:	15 Marks
L	T	P	Total	Theory:	35 Marks
0	0	2	2	Total:	50 Marks
				Duration of Exam:	2 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The aim of this course is to familiarize students with the basics of electronics engineering.

Course Outcomes: After the completion of this course, the students will be able to:

- **CO1-** Understand the operation of half wave & full wave rectifier.
- **CO2-** Understand the transistor as an amplifier.
- **CO3-** Implement amplifiers, differentiator, Integrator and active filters circuit using op amp.
- **CO4-** Design op-amp as Wein-Bridge Oscillator, Square Wave Generator, schimtt trigger and zero crossing detector.
- **CO5-** Write experimental reports and work in a team in professional way.

List of Experiments:

1. Study of Half wave & Full wave rectifiers.
2. Study of Diode as clipper and clamper.
3. Study of CE amplifier for voltage, current & Power gains and input, output impedances
4. Study of CC amplifier as a buffer
5. Design & realize inverting amplifier, non-inverting and buffer amplifier using 741 Op Amp.
6. Verify the operation of a differentiator circuit using 741 op amp and show that it acts as a high pass filter.
7. Verify the operation of a integrator circuit using 741 op amp and show that it ac ts as a low pass filter.
8. Design and verify the operations of op amp adder and subtractor circuits.
9. Design and realize Wein-bridge oscillator using op amp741
10. To design & realize Schmitt trigger using op amp741.
11. To design & realize square wave generator using op amp741.

12. To design & realize zero crossing detector using op amp741.

Note: Any special note if required.

PCC-RAI-306/21 DATA STRUCTURE LAB

B. Tech. (Robotics and Artificial Intelligence) III Semester

No. of Credits:			1	Sessional:	15 Marks
L	T	P	Total	Theory:	35 Marks
0	0	2	2	Total:	50 Marks
				Duration of Exam:	2 Hours

Pre- Requisite: Fundamentals of Computer and Programming in C**.**

Course Objectives:

The objective of studying this course is:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques
3. To understand basic concepts about stacks, queues, lists, trees and graphs.
4. To enable them to write algorithms for solving problems with the help of fundamental data structures

Course Outcomes: At the end of the course, the student shall be able to:

CO1- For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.

CO2- For a given Search problem (Linear Search and Binary Search) student will able to implement it.

CO3- For a given problem of Stacks, Queues, linked list and Tree, student will able to implement it and analyze the same to determine the time and computation complexity.

CO4- Student will able to write an algorithm Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort and compare their performance in term of Space and Time complexity.

CO5- Student will able to implement Graph search and traversal algorithms and determine the time and computation complexity.

List of Experiments:

Programs based on the syllabus of the theory subject are to be implemented in C/C++.

PCC-RAI-401/21 KINEMATICS OF ROBOTS

B. Tech. (Robotics and Artificial Intelligence) IV Semester

No. of Credits:			4	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	1	0	4	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The objective of studying this course is to understand and apply the concepts of kinematics and dynamics of robotics for analyzing the problems.

. **Course Outcomes:** At the end of the course, the student shall be able to:

- **CO1-** Understand the basic concepts of coordinate system.
- **CO2-** Perform kinematic analysis of robots.
- **CO3-** Study inverse kinematics of robots.
- **CO4-** To study manipulator dynamics.

Course Contents:

Unit 1

Introduction to Mechanism and Machine: Links, Kinematic pairs, Degree of freedom, Kinematic Chain, Binary, Ternary, Quaternary Links and Joints, types of mechanism, Mechanical Manipulators, Open kinematic Chain, Inversions of slider crank mechanism.

Unit 2

Robotic configuration: Robot configuration and its different types, robot orientation, types of robots, applications of industrial robots.

Unit 3

Spatial descriptions and transformations: Introduction, Descriptions: Positions, orientation and frames; Mappings: Changing description from frame to frame; Operators: translations, rotations, and transformations; Interpretations, Transformation Arithmetic, Transform equations, representation of orientation, transformation of free vectors, computational considerations.

Unit 4

Manipulator Kinematics: The inverse kinematics problem, General properties of solutions. Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis, Articulated robot. Inverse Manipulator Kinematics, standard frames, (8)

Unit 5

Gear & CAM: Technical terms, types of gear, gear law, interference in gear, minimum number of teeth to avoid interference, Concept of Helical gears, spiral gears, Bevel gear, Gear Trains**:** Types of gear trains: simple gear train, compound gear train, Reverted gear train, Epicyclic gear train. Introduction to CAM, types of follower, types of motion of follower.

Unit 6

Jacobians; velocities and static forces: Introduction, Notation for time varying position and orientation, linear and rotational velocity of rigid bodies, angular velocity, motion of the links of the robots, Velocity "Propagation" from link to link, Jacobians, Singularities, Static forces in manipulations, Jacobians in force domain, Cartesian transformation of velocities and static forces.

Unit 7

Manipulator dynamics: Introduction, acceleration of rigid bodies, mass distribution, Newton's equation, euler equation, Iterative newton – euler dynamic formulation, iterative vs closed form, Example of Closed form dynamic equation, structure of a manipulator's dynamic equation, Lagrangian formulation of manipulator dynamics, Formulating manipulator dynamic in Cartesian space, Inclusion of non-rigid body effects, dynamic simulation, computational considerations.

Text Books/ Reference Books:

1. John J. Craig, Introduction of Robotics, Pearson Education International
2. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning., 2009.
3. Richard D. Klafter, Thomas. A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, Phi Learning., 2009.
4. P.A. Janaki Raman, Robotics and Image Processing an Introduction, Tata Mc Graw Hill Publishing company Ltd., 1995.
5. Francis N-Nagy Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987.
6. Subir Kumar Saha, Introduction of Robotics, 2008.

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PCC- RAI -402/21 ARTIFICIAL INTELLIGENCE
B. Tech. (Robotics and Artificial Intelligence) IV Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Soft Computing, Machine Learning

Course objectives:

1. To understand the domain and strength of AI.

2. To learn searching methods both data and knowledge driven used by inference engine. To assimilate and use the knowledge representations schemes for Intelligent systems.

3. To learn the different aspects of Planning and decision under uncertainty.

4. To learn and apply different aspects of NLP and to have idea about Rule based and Non Rule based expert system

Course outcomes: At the end of the course, the student shall be able to:

CO1- Understand the importance, applicability, and strength of AI.

CO2- Apply various search and knowledge representation schemes for Intelligent system systems

CO3- Develop systems which can handle uncertainty in the inputs and can plan the solution to a problem.

CO4- Understand various phases involved in NLP and understand the architecture of Expert system.

Course Contents:

Unit 1

Fundamental Issues In IS: Definition and Domains of AI, Problems State space, Representations of an AI problem, Criteria for success, Control strategies, Blind search: DFS, BFS, Heuristic search: Hill Climbing (simple & steepest), Best first search/A*, Problem Reduction/AO*, Constraint satisfaction, Means End Analysis

Unit 2

Knowledge Representation: Syntax & Semantic for Propositional logic, Syntax & Semantic for FOPL, Properties for WFF's, Resolution: Resolution Basics, Conversion of predicates into clauses, Resolution of proposition logic, Unification of predicates, Resolution algorithms for predicates, Problems with FOPL, Semantic nets.

Unit 3

Reasoning Under Uncertainty: An introduction, Default reasoning & Closed world assumptions, Fuzzy logic, Bayes' Theorem, Bayesian Probabilistic inference, Dempster Shafer theory, Model & Temporal logic: Hidden Markov Model,

Planning & Learning: Planning, Representation for planning: Situational calculus, Strips, ADL, Partial order planning algorithm, Neural Networks, Inductive Learning, Genetics algorithms

Unit 4

Natural Language and Expert System Development Life Cycle: Introduction to Natural Language Processing, Morphology, Syntax Analysis, Expert system: Definition, Role of knowledge in expert system, Architecture of expert system (Rule Based and Non-Rule Based), Expert System Development Life Cycle, Example of at least two expert system.

Text / Reference Books:

1. Rolston, David W. "Principles of Artificial Intelligence and Expert Systems Development" McGraw-Hill, Inc.
2. Rich, Elaine, and Kevin Knight. "Artificial Intelligence McGraw–Hill." New York.
3. Nilsson, Nils J. "Principles of Artificial Intelligence" Springer Science & Business Media.
4. Norvig, Peter and Russel, Stuart. "Artificial Intelligence: A modern approach." Prentice Hall Upper Saddle River, NJ, USA: Rani, M., Nayak, R., & Vyas.
5. Winston, Patrick Henry "Artificial intelligence" Addison-Wesley Longman Publishing Co.

PCC-RAI-403/21 DESIGN OF MACHINE ELEMENTS
B. Tech (Robotics and Artificial Intelligence) IV Semester

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total: 100 Marks
	Duration of Exam: 3 Hours

Pre- Requisite: Materials Engineering, Engineering Mechanics

Successive: Nil

Course Objectives:

To study the concept mechanical design, material selection, design of different joints, keys & couplings

Course Outcomes: At the end of the course, the student shall be able to:

CO 1- Explore concepts of mechanical drawing and principles of mechanical design.

CO 2- Select different types of materials for mechanical components.

CO 3- Understand design of different types of mechanical fasteners & joints.

CO 4- Design different types of keys & couplings.

Course Contents:

Unit 1

Mechanical Drawing: Different types of riveted, welding joints and their free hand drawings. Sectional views, dimensioning, concept of limits, fits & tolerances and their representation. (8)

Unit 2

Principles of Mechanical Design: General considerations & procedure of design of machine elements, static loading, factor of safety under different loading conditions, Concept of fatigue failures against dynamic loading. Fatigue design for finite and infinite life against combined variable stresses using Goodman and Soderberg's Criterion**,** Failure Theories. (8)

Unit 3

Engineering Materials: Classification & mechanical properties of materials, Selection of material, Composite materials: Types, classification Metal matrix composites, Fiber reinforced plastics, Stress, strain analysis of continuous fiber composites, rule of mixtures. (6)

Unit 4

Mechanical Fasteners: Design of riveted joints, Design of welding joints and Design of screwed joints. Mechanical fasteners against static load, eccentric loads. Different type & design of cotter joints, Design of knuckle joint. (12)

Unit 5

Keys & Couplings: Design of different type of keys; sunk key, saddle key, tangent key, round key & splines. Design of different shaft couplings against torque; Rigid & Flexible couplings. (6)

Unit 6

Design of Miscellaneous Components: Bearing: Introduction, types & selection of bearing based on static and dynamic load. Load-life relationship, Lubrication. Gear: Classification, Selection of gears, Terminology of gears, Force analysis, Form or Lewis factor for gear tooth (8)

Text Books:

1. P. S Gill, "Machine Drawing", S K Kataria and sons,
2. N. D. Bhatt, "Machine Drawing". Charotar publications,
3. Design of Machine Elements – V. B. Bhandari – Tata McGraw Hill, New Delhi.
4. Machine Design Data Book by V. B. Bhandari
5. Design Data Handbook for Mechanical Engineering by Mahadevan, k, Reddy, K

Reference Books*:*

1. Mechanical Engineering Design- Joseph Edward Shigley-Mc Graw Hill Book Co.
2. Machine Design – An Integrated Approach by Robert L. Norton

PCC-RAI-404/21 MICROPROCESSOR & MICROCONTROLLER

B. Tech. (Robotics and Artificial Intelligence) IV Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

On successful complete of this course, the students should be able to:

1. To acquire insight into architectural details of microprocessors, assembly language programming, and different bus structures.

2. To acquire insight into architectural details of microcontrollers, assembly language programming, and different bus structures.

3. To understand various types of interrupts of the microprocessors and microcontrollers, along with implement the interfacing of external devices.

4. To analyse the hardware/software trade-offs involved in the design of microprocessor and microcontroller-based systems.

Course Outcomes: At the end of the course, the student shall be able to:

- **CO1-** Acquaint with the architecture, operations, the addressing modes, instruction set and programming of the microprocessors.
- **CO2-** Accustom with the architecture, operations, the addressing modes, instruction set and programming of the microcontrollers.
- **CO3-** Recognize the various types of interrupts of the microprocessors and microcontroller along with implementation of the interfacing of external devices to the processor.
- **CO4-** Understand and apply the hardware/software trade-offs involved in the design of microprocessor and microcontroller-based systems.

Course Contents:

Unit 1

Microprocessor 8086: Architecture, Overview of 8086 microprocessor-Functional Diagram, Register Organization, Memory Segmentation, Signal Descriptions-Common Function Signals, Minimum and Maximum Mode Signals, Timing Diagrams, Interrupts of 8086.

Unit 2

Assembly language of 8086: Instruction Set, Addressing Modes, Assembler directives, 8086 Assembly Programming- simple programs involving logical, branch and call instructions, sorting, evaluating arithmetic expressions, string manipulations.

Unit 3

Interfacing with Microprocessors: Interfacing with RAMs, ROMs. Interfacing with peripheral ICs- programmable peripheral interface 8255, programmable interrupt controller 8259 and 8254 programmable timer. Interfacing with keyboards, LEDs, LCDs, ADCs, and DACs.

Unit 4

Microcontroller 8051: Overview of 8051 microcontroller- Architecture, memory organization, inbuilt modules- timers, serial communication module, port operation: special function registers, timing and control and interrupts.

Unit 5

Microcontroller, Instruction Set and Programming: Programming the 8051, Operand types, Operand addressing, Data transfer instructions, Arithmetic Instructions, Logic instructions, Control transfer instructions. 8051 Interfacing - memory and I/O interfacing. ()

Text Books/ Reference Books:

1. Ramesh S Gaonkar, "Microprocessor Architecture, Programming & Applications with 8085", Wiley Eastern Ltd.
2. A K Ray, K M Bhurchandi," Advanced Microprocessors and Peripherals", TMH Publications.
3. Kenneth J. Ayala, The 8051 Microcontroller, Penram International Publishing, 1996.
4. Hall, "Microprocessors and interfacing", TMH
5. Triebel, Singh,"The 8088 & 8086 Microprocessors-Programming, interfacing, Hardware & Applications", PHI
6. Yu-Chang Liu, Glenn A Gibson,"Microcomputer systems: the 8086/8088 Family: architecture, Programming & Design", PHI.
7. Barry B. Brey, "The Intel Microprocessors: Architecture, Programming & Interfacing" PHI, 6th Edition.
8. Uffenback, "The 8086 Family Design" PHI, 2nd Edition.
9. Muhammad Ali Mazidi "The 8051 Microcontroller and Embedded Systems" Pearson publications.

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PCC-RAI-405/21 MECHATRONICS SYSTEM DESIGN
B. Tech. (Robotics and Artificial Intelligence) IV Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: IoT, Signal Processing and Machine Learning.

Course Objectives:

To study essential concepts of a system model in a mechanical system. To study interfacing of various hardware in mechatronics product design for enhancing mechanical product design values.

Course Outcomes: At the end of the course, the student shall be able to:

- **CO1-** Understand conceptual design for mechatronics products based on potential custom requirements.
- **CO2-** Analyze appropriate sensors and transducers for mechatronics applications.
- **CO3-** Calculate transfer function for first order and second order system.
- **CO4-** Develop system model for mechanical system.

Course Contents:

Unit 1

Introduction to Mechatronics systems and components, Mechatronics product design, Applications, Principles of basic electronics with their applications in Mechanical Engineering, Mechatronics in robots, Analogy between mechanical and electrical system.

Unit 2

Microcontrollers applications in design of mechanical equipment's. Interfacing. amplifiers applications in mechatronics product design. Low pass and high pass filters.

Unit 3

Sensors –sensors and transducers. Displacement, position proximity sensors, velocity, force sensors. Fluid sensors, Temperature sensors, Liquid level and Light sensors. Selection of sensors, Actuators: Pneumatic and hydraulic systems, Electrical actuation system.

Unit 4

Principles of Electronic system communication, Signal conditioning, Interfacing, A.D. and D.A. convertors, Software and hardware principles and tools to build mechatronic systems, Basic system models, Mathematical models.

Unit 5

Control System – Proportional, Derivative and Integral control, Controller tuning, PID Controllers, System Transfer functions, First and second order.

Unit 6

Design and selection of Mechatronics components namely encoders, stepper and servomotors, ball screws, solenoids, application to CNC system. PLC and Ladder programming.

Text Books/ Reference Books:

1. Mechatronics by W. Bolton, published by Pearson Education, 4th Ed.
2. Automation Production System and CIMS by Mikel P Groover, Prentice Hall of India New Delhi.

Web Links: http://nptel.ac.in, Mechatronics Engineering

Note: It is recommended that some part of the syllabus is to be covered in online mode.

MCEVS-02 NATIONAL RESOURCES AND BIODIVERSITY CONSERVATION
B.Tech (Robotics and Artificial Intelligence) IV Semester

No. of Credits: 3
LT P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Outcomes (COs): At the completion of this course, the learner will be able to:

CO1- Illustrate types of resources and consequences of resource degradation.

CO2- Appraise the food and land resources and role of individual in conservation of resources.

CO3- Interpret ecological and social phenomena from a biodiversity view point.

CO4- Develop new conservation measures on new or endangered species in a given habitat.

Course Contents:

Unit 1

Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems: **Forest Resources**: Use and Over-exploitation, deforestation. Case studies. Timber exaction mining, dams and their effects on forests and tribal people. **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams, benefits and problems. **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

Unit 2

Food Resources: World food Problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. **Energy resources;** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, Case studies.
Land resources: Land as a resource, Soil profile and horizons, Soil formation and degradation, man induced landslides, soil erosion and desertification. Role of and individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Unit 3

Biodiversity Uses, Threats and Conservation: Introduction- Definition: genetic, species and ecosystem diversity. Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, Social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation.

Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife. man-wildlife conflicts. Endangered and endemic species of India.

Unit 4

Conservation of Biodiversity: In-situ and Ex-situ conservation of biodiversity, Special Projects for endangered species: Project tiger, Project Gir lion, Project elephant and Project crocodile. Role of WWF, IUCN, UNEP, Red Data Book in restoration of endangered species.

Reference Books:

1. Joshi, B.D., Tripathi, C.P.M and Joshi, P.C. Biodiversity and Environmental Management. APH, New Delhi, 2009.

2. Joshi, P.C. and Joshi, N. Biodiversity and conservation. APH Publishing Co- operation, New Delhi, 2009.

3. Fatik B. Manda! and Nepal C. Nandi. Biodiversity: Concepts, Conservation and Bio.future, Asian Books, 2013.

Suggested Web Sources:

1. http: //cnvisnic.in/l :NVIS html/l_NVISSubjcct/s ubjcct.html

2 https://nptel.ac.in/courses/103/106/103106162/

3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14

4. https://swayam.gov.in/

MC-02 ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

B. Tech (Robotics and Artificial Intelligence) IV Semester

No. of Credits: 0
L T P Total
2 0 0 2

Sessional: 25 Marks
Theory: 75 Marks
Total : 100 Marks
Duration of Exam: 3 Hours

भारतीयिवÇासार – 1

Course Objective:

The course aims at imparting basic principles of thought process, reasoning and inferencing. Sustainability is at the core of Indian Traditional knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. Part-I focuses on introduction to Indian Knowledge Systems, Indian perspective of modern scientific world-view, and basic principles of Yoga and holistic health care system.

Course Contents Basic structure of Indian Knowledge System: अ'ादशिवÇा -४वेद,४उपवेद (आयुव॓द, धनुव॓द,–गzवाेवेद, थापr आिद) ६वेदांग (ि◌शH◌ा, कB, ि◌नSb, fŋ◌ाकरण, Ů◌ोि◌तष, छंद) ४उपाड्ग (धमाेशा◌., मीमांसा, पुराण, तकाे शा◌.) Modern Science and Indian Knowledge System– Yoga and Holistic Health care– Case studies–

Course Outcomes: At the end of the course, the student shall be able to:

CO1- Understand the Indian traditional knowledge.

CO2- Understand & Recall the Ancient Indian scriptures.

CO3- Correlate Modern Science and Indian Knowledge System.

CO4- Relate Yoga and Holistic Health care along with case study.

Course Contents:

Unit 1

Introduction of Traditional Knowledge: Indian traditional knowledge of social, science, medicines, warfare, judiciary etc.

Unit 2

Ancient Indian scriptures:

Veda--- Meaning, Types of Vedas-- Rig-Veda, Sama-Veda, Yajur-Veda, and Atharva-Veda,;

Upveda---Meaning, types of upveda, Description of each upveda;

Vedang--- Meaning, no. of Vedang, Description of each Vedang;

Updesha: Dharmshastra, Mimans, Puran, Tarkshastra., Important scriptures of scripture of other religions

Unit 3

Modern Science and Indian Knowledge System: Various field of Indian knowledge; Communication, Mathematics, Phonetics, Metaphysics and Philosophy, Life Sciences, Medical Sciences, Cosmology, Military Science etc.

Unit 4

Yoga and Holistic Health care: Introduction, Yogic Concepts of Wellbeing, Relationship between Health and Disease, Maintain wellbeing,Aurveda.

Unit 5

Case study of development of an Aurvedic treatment centre; Patanjali; Development of Yoga as World Yoga Divas; any other case study related to Indian traditions.

Recommended/ Reference Books:

1) V. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bharatiya,VidyaBhavan, Mumbai.
2) Swami Jitatmanand, Modern Physics and Vedant, Bharatiya VidyaBhavan•
3) Swami Jitatmanand, Holistic Science and Vedant, Bharatiya VidyaBhavan•
4) Fritzof Capra, Tao of Physics
5) Fritzof Capra, The Wave of life• VN Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, International Chinmay• Foundation, Velliarnad, Arnakulam Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata
6) GN Jha (Eng. Trans.), Ed. RN Jha, Yoga-darshanam with Vyasa Bhashya,
7) VidyanidhiPrakashan, Delhi RN Jha, Science of Consciousness Psychotherapyand Yoga Practices, Vidyanidhi
8) Prakashan, Delhi P B Sharma (English translation), ShodashangHridayan
9) Pedagogy: Problem based learning, group discussions, collaborative mini projects. Outcome: Ability to understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective.

Web Links:

S.N.	Web Link	Contents
1	Portalvedicheritage.gov.in	Vedic Heritage
2	Encyclopediawww.ancient.eu	The Vedas - Ancient History
3	https://youtu.be/SgR9sdy6y8A	Veda video lecture
4	https://youtu.be/3ODfwJBDgBs	Yoga
5	ics.purdue.edu ›	Ancient India
6	www.ncbi.nlm.nih.gov	Physicians of ancient India

PCC-RAI-406/21 ARTIFICIAL INTELLIGENCE LAB

B. Tech. (Robotics and Artificial Intelligence) IV Semester

No. of Credits:			1		
L	T	P	Total	Sessional:	15 Marks
0	0	2	2	Theory:	35 Marks
				Total:	50 Marks
				Duration of Exam:	2 Hours

Pre- Requisite: None

Successive:

Course Objectives:

The aim of this course is to familiarize students with PROLOG.

Course Outcomes: After the completion of this course, the students will be able to:

- **CO1-** Understand the basic about the importance of PROLOG
- **CO2-** Learn about the various syntax and semantics of the language.
- **CO3-** Gain knowledge of the implementation of various programs in PROLOG
- **CO4-** Design small Expert System i.e Medical ES, Electrical ES.

List of Experiments:

1. Study of Prolog.
2. Write simple fact for the statements using PROLOG.
3. WAP
   - (i) To check whether an element is member of a list or not.
   - (ii) To check whether a list is subset of another list or not.
   - (iii) To append/Concatenate one list after another list.
   - (iv) To delete all occurrence of an element from a list.
   - (v) Compare two lists.
   - (vi) Find reverse of a list.
   - (vii) To implement Factorial, Fibonacci of a given number.
   - (viii) Count the number of element in a list.
   - (ix) Find sum of elements in a list
   - (x) To check whether two lists are equal or not when they are not in same order.
4. WAP to find UNION and INTERSECTION of two lists.
5. Write a program in prolog to solve Tower of Hanoi
6. WAP to find route map for different cities.

7. WAP to Solve DFS and BFS in PROLOG.
8. WAP to Sort list using Selection, Insertion, Merge and Quick Sort.
9. Write a program to solve the Monkey Banana problem.
10. Write a program to solve (4/8)-Queen problem.
11. WAP in turbo prolog for Medical Expert System
12. WAP in turbo prolog for Electrical Expert System

PCC-RAI-407/21 MICROPROCESSOR & MICROCONTROLLER LAB

B. Tech. (Robotics and Artificial Intelligence) IV Semester

No. of Credits:			1	Sessional:	15 Marks
L	T	P	Total	Theory:	35 Marks
0	0	2	2	Total:	50 Marks
				Duration of Exam:	2 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The aim of this course is to familiarize students with Microprocessor & Microcontroller.

Course Outcomes: After the completion of this course, the students will be able to:

- **CO1-** Identify various modules embedded on the kit.
- **CO2-** Write the assembly code for various operations on 8-bit and 16-bit numbers.
- **CO3-** Interface various peripherals with microprocessor and to write the program for same.
- **CO4-** Interface various devices such as seven segment LEDS & stepper motor with microprocessor through 8255 and to write the program for same.

List of Experiments:

1. Study of architecture of microprocessors 8086 & familiarization with its hardware, commands & operation of Microprocessor kit.
2. Write a program using microprocessors and verify for :

(i) Addition of two 8-bit numbers.

(ii) Addition of two 8-bit numbers (with carry).

3. Write a program using microprocessors and verify for :

(i) 8-bit subtraction (display borrow)

(ii) 16-bit subtraction (display borrow)

4. Write a program using microprocessors for multiplication of two 8- bit numbers by repeated addition method and bit rotation method and verify.
5. Write a program using microprocessors for division of two 8- bit numbers by repeated subtraction method and bit rotation method and test for typical data.
6. Write a program using microprocessors and verify for:

(i) Finding the largest number from an array.

(ii) Finding the smallest number from an array.

7. Write a program using microprocessors for arranging an array of numbers in descending and ascending order and verify.
8. Write a program using microprocessors for finding square of a number using look-up table and verify.
9. Write a program to interface microprocessors with 8253 to generate square wave.
10. Write a program to interface microprocessors with 8253 to generate interrupt on terminal count.
11. Write a program to interface a two-digit number using seven-segment LEDs. Use microprocessor and 8255 PPI.
12. Write a program to control the operation of stepper motor using microprocessors and 8255 PPI.

PCC-RAI-408/21 KINEMATICS OF ROBOTS LAB

B. Tech. (Robotics and Artificial Intelligence) IV Semester

No. of Credits:			1	Sessional:	15 Marks
L	T	P	Total	Theory:	35 Marks
0	0	2	2	Total:	50 Marks
				Duration of Exam:	2 Hours

Pre- Requisite: Kinematics of Machines

Successive: Dynamics of Machines.

Course Objectives:

The objective of this course is to demonstrate the basic elements of machine members and its arrangement to make a mechanism, such as mechanisms, cam, gears etc.

Course Outcomes: After the completion of this course, the students will be able to:

- **CO1-** Understand the Mechanism and Machine.
- **CO2-** Discuss the concept of velocity and acceleration
- **CO3-** Measure application of Friction.
- **CO4-** Learn the concepts and application of Gears, CAMs.

List of Experiments:

1. Kinematics of four bar, slider crank, crank rocker, double crank, double rocker and oscillating cylinder mechanisms.
2. Study of components of real Robot and its DH parameters.
3. Study and Drafting of various types of end effector.
4. To generate spur gear involutes tooth profile using simulated gear shaping process.
5. To study various types of gears- Helical, cross helical worm and bevel gear.
6. Estimation of Velocity ratios of simple, compound, epicyclic and differential gear trains
7. To Study Cam and follower combination.
8. Study of various manipulators of Robots
9. Generation of simple robot program for motion
10. To determine the Torque by Epicyclic gear train torque measuring machine.

PCC-RAI-501/21 CAD/CAM

B.Tech. (Robotics and Artificial Intelligence) V Semester

No. of Credits:			3
L	T	P	Total
3	0	0	3

Sessional:	25 Marks
Theory:	75 Marks
Total:	100 Marks
Duration of Exam:	3 Hours

Pre- Requisite: **Nil**

Successive: Nil

Course Objectives:

To understand the fundamentals of CAD and CAM for development of mechanical systems.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Understand the basic fundamentals of computer aided designing.

CO 2- Learn development of curves, surfaces, solid models for mechanical designs and FEA.

CO 3- Understand basics of NC, CNC, DNC, FMS, CIM, CAPP etc.

CO 4- Acquire knowledge about latest intelligent technologies.

Course Contents:

Unit 1

Basics of CAD: Need and Scope of Computer Aided Design, Fundamental of CAD and computer graphics- Application areas, Comparison of CAD with Manual designing, Benefits of CAD, UCS, 3D systems, 2D geometrical transformations, Matrix representations and homogeneous coordinates, composite transformations, transformations between coordinate systems. 2-D viewing, 3-D Geometric transformations, composite transformations, Importance of transformations.

Unit 2

Curves and Surfaces: Representation of circle, Arc, Ellipse, parabola and hyperbola. Synthetic Curves**;** Concept of continuity, Cubic Spline: equation, properties and blending. Bezier Curve: equations, properties; Properties and advantages of B-Splines and NURBS. Types of surfaces used in automotive industry along with their applications.

Unit 3

Solid Modelling: Geometry and Topology, Comparison of wireframe, surface and solid models, Properties of solid model, properties of representation schemes, Concept of Half-spaces, Boolean operations. Schemes: B-rep, CSG, Sweep representation, ASM, Primitive instancing, Cell Decomposition Techniques.

Unit 4

Finite Element Analysis: Introduction to FEA, failure analysis under static and dynamic loading, Preprocessing, Elements used in FEA, Material defining, Meshing, loading, constraints and boundary conditions, post processing and reviewing the results.

Unit 5

Computer Aided Manufacturing: Industrial robots, Introduction to NC, CNC & DNC, Flexible Manufacturing System, Automated guided vehicle systems, Automated storage and retrieval system, Computer Aided Process Planning.

Unit 6

Latest Technologies: Introduction to Industry 4.0, FEM, Reverse engineering and computer aided inspection, cloud manufacturing, artificial intelligence and machine learning.

Text Books:

1. Ibrahim Zeid *CAD/CAM - Theory and practice Tata McGraw Hill* Publishers.
2. David Rogers and J. Alan Adams, *Mathematical Elements for Computer Graphics* by McGraw Hill
3. Salomon, D. *Transformations and projections in computer graphics* Springer.
4. Rao, P.N., CAD / CAM Principles and Applications, McGraw Hill Publishers, New Delhi
5. M.P. Groover, Automation, production systems and Computer-integrated Manufacturing, Eastern Economy Edition.

Reference Books:

1. Yoram Koren, Computer Control of Manufacturing Systems, McGraw Hill Publications, 2005.
2. Nanua Singh, System approach to Computer-integrated design and manufacturing, , Wiley India.
3. T. C. Chang, R. A. Wysk and H. P. Wang, Computer Aided Manufacturing, Pearson

PCC- RAI -502/21 DIGITAL SIGNAL PROCESSING

B. Tech. (Robotics and Artificial Intelligence) V Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

On successful complete of this course, the students should be able to:

1. To give understanding of analytical tools such as Fourier transforms, Discrete Fourier transforms, Fast Fourier Transforms and Z-Transforms required for digital signal processing.
2. To understand various structures of IIR and FIR systems.
3. To study design and realize of various digital filters for digital signal processing.
4. To introduce Multirate Digital signal processing.

Course Outcomes: At the end of the course, the student shall be able to:

- **CO1-** The students will be able to understand the analytical tools such as Fourier transforms, Discrete Fourier transforms, Fast Fourier Transforms and Z-Transforms required for digital signal processing.
- **CO2-** The students will get familiarized with various structures of IIR and FIR systems.
- **CO3-** The students will be able to design and realize various digital filters for digital signal processing.
- **CO4-** The students will be able to understand the Multirate Digital signal processing.

Course Contents:

Unit 1

Introduction to Digital Signal Processing: Discrete time signals & systems, linear shift invariant systems, stability and causality, Discrete time systems described by difference equations, Frequency domain representation of discrete time signals and systems, Discrete Time Fourier Transform, Review of Z-transforms.

Unit 2

Discrete Fourier Transform and FFT

Discrete Fourier transforms, frequency domain sampling, circular convolution, Computation of DFT, Relationship of DFT to other transforms, Properties of DFT, Fast Fourier transforms (FFT). ()

Unit 3

Realization of Digital Filters: Structures for FIR systems: Direct form structure, Cascade form structures, Structures for IIR systems: Direct form structures, Signal flow graphs and transposed structures, cascade form structures, Parallel form structures.

Unit 4

Design of FIR Digital Filters: Symmetric and antisymmetric FIR filters, Design of linear phase FIR Digital Filters using Windows. DESIGN OF IIR DIGITAL FILTERS: IIR filter design by Approximation of Derivatives, IIR filter design by impulse invariance, IIR filter design by bilinear transformation. Comparison of IIR & FIR filters.

Unit 5

Multirate Digital Signal Processing: Decimation by a factor D, interpolation by a factor I, sampling rate conversion by a rational factor I/D, Multi stage Implementation of sampling rate conversion.

Text Books/ Reference Books:

1. S.K.Mitra, Digital Signal Processing: A computer based approach.TMH.
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall.
3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms And Applications, Prentice Hall.

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PCC- RAI -503/21 MACHINE LEARNING AND APPLICATION

B. Tech. (Robotics and Artificial Intelligence) V Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Artificial Intelligence

Course Objectives:

1. To learn and understand the features of machine learning to apply on real world problems and other applications.
2. To design and analyze various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
3. Explore supervised and unsupervised learning paradigms of machine learning.
4. To explore Deep learning technique and various feature extraction strategies.

Course Outcomes: At the end of the course, the student shall be able to:

CO1- Extract features that can be used for a particular machine learning approach in various applications and real world scenarios.

CO2- To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.

CO3- To mathematically analyze various machine learning approaches and paradigms

CO4- To understand deep learning algorithms and their strategies

Course Contents:

Unit 1

Supervised Learning (Regression/Classification) Basic methods: Distance-based methods, Nearest-Neighbors, Decision Trees, Naive Bayes Linear models: Linear Regression, Logistic Regression, Generalized Linear Models Support Vector Machines, Nonlinearity and Kernel Methods Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

Unit 2

Clustering: K-means/Kernel K-means Dimensionality Reduction: PCA and kernel PCA Matrix Factorization and Matrix Completion Generative Models (mixture models and latent factor models)

Unit 3

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Unit 4

Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning: perceptrons, Feed forward neural network, backpropagation, gradient descent,

Feature Representation Learning

Unit 5

Scalable Machine Learning (Online and Distributed Learning), Introduction to Bayesian Learning and Inference, Recent trends in various learning techniques of machine learning and classification methods.

Text Books/ Reference Books:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007

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BSC-501-RAI PROBABILITY AND STATISTICS

B. Tech. (Robotics and Artificial Intelligence) V Semester

No. of Credits:			4	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	1	0	4	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Course Objectives: The objective of this course is to: (i) introduce the basic concepts of probability and random variable to study random experiments (ii) use statistical methods for collection of data and extract information from the data (iii) inculcate the knowledge for applying test of significance in real life problems.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO1- Study random experiments by using basic concepts of Probability and random variables.

CO2- Apply standard discrete and continuous probability distributions in solving the real life problems while dealing with random experiments.

CO3- Compute the quantitative measures and fit some standard distributions and curves to the data. Compute the measures of association between two quantitative as well as qualitative random variables.

CO4- Apply tests of significance for population proportion (one and two sample problems), mean and variance of normal distribution (one and two sample problems) and tests of goodness of fit.

Course Contents:

Unit 1

Introduction to Probability: Random experiments, sample space, events, algebra of events, three approaches to probability, conditional probability, total probability theorem and Bayes theorem. Univariate random variables: discrete and continuous, density function, cumulative distribution function. Expected value, moments and moment generating function (mgf) to find moments of univariate random variable, Chebyshev's Inequality. (8)

Unit 2

Probability Distributions: Discrete distributions: Bernoulli, binomial, Poisson, hypergeometric and multinomial. Approximation of binomial distribution by Poisson distribution. Continuous Distributions: Normal, uniform, Exponential and Gamma distributions (definition of random variables associated with these discrete and continuous distributions, their probability mass functions/probability density functions along with the shape of their graphs, finding moments from their mgf.

Unit 3

Bivariate Distributions: Bivariate random variable: joint, marginal and conditional density functions, independent random variables, some numerical problems to find marginal and conditional density functions from joint density function. Bayes' rule. Concept of multivariate random variable. Bivariate normal distribution (definition) and associated conditional and marginal distributions. Covariance and Karl Pearson's correlation coefficient between two random variables.

Unit 4

Basic Statistics: Collection of data on a univariate and bivariate random variables using simple random sampling. Measures of Central tendency, Moments, Skewness and Kurtosis based on the data from a distribution. Estimation of parameters of Binomial, Poisson and Normal distributions and fitting of these distributions. Bivariate data and estimation of Karl Pearson's correlation coefficient. Spearman's rank correlation.(9)

Unit 5

Applied Statistics: Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves, multiple linear regression. Test of significance, steps involved in a test of significance. Test of significance for single mean, difference of means, and difference of standard deviations of normal distributions. Large sample tests for single proportion, difference of proportions. Concept of Attribute, Measures of association between two attributes in the context of 2x2 contingency table. t-test, Chi-square test of goodness of fit and independence of attributes.(12)

Text Books/ Reference Books:

1. Johnson, R.A., Miller, I and Freund J., Miller and Freund's Probability and Statistics for Engineers, Pearson Education, Asia, 8th Edition, 2015.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11 th Edition, Sultan Chand & Sons, 2017.
3. Devore. J.L., Probability and Statistics for Engineering and the Sciences, New Delhi, 8th Edition, 2014.
4. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., ―Probability and Statistics for Engineers and Scientists, 8th Edition, Pearson Education, Asia, 2007.
5. S. Ross, A First Course in Probability, Pearson Education India.
6. John E. Freund, Ronald E. Walpole, Mathematical Statistics, Prentice Hall.

Web Links: Note: It is recommended that some part of the syllabus is to be covered in online mode

PCC- RAI -504/21 COMMUNICATION SYSTEMS

B. Tech. (Robotics and Artificial Intelligence) V Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

On successful complete of this course, the students should be able to:

• To learn about the basics of communication systems and different types of signal used for communication.

• To understand the Amplitude modulation and its different types.

• To describe the concept of Angle modulation.

• To understand digital modulation and different digital modulation techniques.

• To introduce the students about noise.

Course Outcomes: At the end of the course, the student shall be able to:

- **CO1-** Understand the basics of communication systems and different types of signal used for communication.
- **CO2-** Describe and understand the Amplitude modulation and its different types.
- **CO3-** Explain and analyses the concept of Angle modulation.
- **CO4-** Learn the concept of Digital modulation and different digital modulation techniques.
- **CO5-** Introduce the concept of noise and its effect on communication systems

Course Contents:

Unit 1

Introduction to Communication Systems: The essentials of a Communication system, modes and media‘s of Communication, Classification of signals.

Unit 2

Amplitude Modulation

Amplitude modulation, Generation of AM waves, Demodulation of AM waves, DSBSC, Generation of DSBSC waves, Coherent detection of DSBSC waves, single side band modulation, generation of SSB waves, demodulation of SSB waves, vestigial sideband modulation (VSB). ()

Unit 3

Angle Modulation: Basic definitions: Phase modulation (PM) & frequency modulation (FM), narrow band frequency Modulation, wideband frequency modulation, generation of FM waves, Demodulation of FM waves.

Unit 4

Pulse Modulation: Sampling theory, pulse amplitude modulation (PAM), pulse time modulation., Elements of pulse code modulation, Quantization, Uniform & nonuniform Quantization, Necessity of nonuniform quantization, A law of Companding, μ law of companding, Quantization error in PCM, transmission BW of PCM, Differential Pulse Code Modulation, Delta Modulation, Adaptive Delta Modulation, TDM, FDM.

Unit 5

Digital Modulation Techniques: ASK, Generation and detection of ASK, FSK Generation and detection of FSK, BPSK , Generation & detection of BPSK, QPSK, generation and detection of QPSK, DPSK, M-ary PSK.

Unit 6

Introduction to Noise: External noise, internal noise, S/N ratio, noise figure, noise temperature.

Text Books/ Reference Books:

1. Communication systems (4th edn.): Simon Haykins; John wiley & sons.
2. Communication systems: Singh & Sapre; TMH.
3. Electronic Communication systems: Kennedy; TMH.
4. Communication Electronics: Frenzel; TMH.
5. Communication system: Taub & Schilling; TMH.
6. Communication systems: Bruce Carlson.

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PCC-RAI-505/21 DESIGN AND FABRICATION LAB

B.Tech. (Robotics &Artificial Intelligence) V Semester

No. of Credits: 1 Sessional: 15 Marks
L T P Total Theory: 35 Marks
0 0 2 2 Total: 50 Marks

Pre- Requisite: Nil
Successive: Nil

Course Objectives:
To understand the fundamentals of CAD, CAE and CAM tools for Design and optimization.

Course outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Display & exploring CAD modelling package.
CO 2- Learn the techniques of 3D modelling & programs on CNC machine

List of Experiments:

1. Introduction to CAE tools and working with sketch mode.
2. Working with basic tools for creating features, Point, Axis and Planes.
3. Working with advanced modelling tools (Sweep, Blend, Variable section Sweep, Swept Blend & Helical Sweep).
4. Assembly modeling, Generating, editing and modifying drawings in CATIA/ Solidworks/ ProE.
5. FEA of the cantilever beam with concentrated load and UDL using CAE tools
6. To perform various operation on CNC turning centre.
7. Introduction of PCB, PCB Tools & Softwares.
8. Schematic to layout Design & placement of components. Footprint on graph paper & connecting the components with tracks on Inch Paper.
9. Cutting Cu clad sheet according to layout measurement & mirror imaging of the desired layout on copper clad sheet.
10. Creating the PCB tracks using permanent marker or (heating and pressing) on board materials at high temperatures.
11. Drilling holes and Etching for removing excess copper from the surface to reveal traces and pads
12. Making the final PCB & testing.

 # Minimum 10 experiments are to be covered from above list. First 06 experiments will be covered by Mechanical Department and rest 06 will be covered by Electronics Department.

PCC-RAI-506/21 PYTHON PROGRAMMING LAB

B. Tech. (Robotics and Artificial Intelligence) V Semester

No. of Credits:			1	Sessional:	15 Marks
L	T	P	Total	Theory:	35 Marks
0	0	2	2	Total:	50 Marks

Pre- Requisite: C, Data Structures

Course Objectives:

The aim of this course is to understand and learn Python, a useful scripting language constructs for developing various applications.

Course Outcomes: After the completion of this course, the students will be able to:

- **CO1-** Use python constructs such as lists, sets, tuples, dictionaries
- **CO2-** Understand numpy, pandas for representing compound data, read and write data from/to files in python
- **CO3-** Able to generate, analyze and interpret data using Python.
- **CO4-** Design and implement predictive models from data and analyze their performance.

List of Experiments:

1. Declare a function named reverse_ list. It takes an array as a parameter and returns the reverse of the array.
2. Write a program to create, concatenate and print a string and accessing sub-string from given string.
3. Write a python script to print the current date in the fallowing format"Tues March 15 02:26:23 IST 2022".
4. Create a new list using Lambda function to store squares of all the numbers.
5. Create a class containing name, age, and profession of an individual. Create another class that inherits the previous class and print required values.
6. Write a function which returns true if the string has balanced parentheses.
7. Use map to create a new list by changing each number to its square in the numbers list.
8. Create an 8X8 matrix and fill it with checkboard pattern.
9. Write a program that input a text file .the program should print all of the unique words in the file in alphabetical order.
10. Write a script named copyfile.py. This script should prompt the user the names of two text files. the contents of the first file should be input and written to the second file.

11. A robot moves in a plane starting from the original 0 position. The robot can move toward up, down, left and right with a given steps the trace of robot movement is shown the number after the directions are steps. Write a program to compute the distance from current position after a sequence of movement and original point.
12. Create a numpy array of evenly spaced 24 numbers.
    a) Get all the items from position 3 upto 18.
    b) Reshape the array into 6X4 dimensions
    c) Split the array in 4 array columns horizontally
13. Construct two data frames namely left and right using following dictionaries.

    left_data = {'key1': ['a', 'b', 'c'], 'key2': ['x', 'y', 'z'], 'lval1': [0, 1, 2]}
    right_data = {'key1': ['a', 'b', 'c'], 'key2': ['x', 'a', 'z'], 'rval1': [6, 7, 8]}
    Perform all four types of joins on these two frames.

14. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
15. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
16. Write a Python program to implement Simple Linear Regression.
    a) Calculate the SSE (sum of squared error)
    b) Calculate the RMSE (Root Mean Square Error) value
    c) Calculate the coefficient of determination (r 2) r-square
    d) Plot regression line along with the given data points
17. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
18. Implement Multiple Linear Regression for House Price Prediction using sklearn.
19. Implement Logistic Regression using sklearn.
20. Implement K-Means Clustering.

PCC-RAI-601/21 INTRODUCTION TO IOT

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

1. To understand the definition, fundamental concepts and significance of the Internet of Things
2. To discuss the architecture, operation, and constraints effecting the design of IoT structure.
3. To analyse and understand the roles of sensors in IoT.
4. To learn different protocols used for IoT design.
5. To explore role of IoT for various application.

. **Course Outcomes:** At the end of the course, the student shall be able to:

CO1- Understand the definition, fundamental concepts and significance of the Internet of Things

CO2- Describe various structures of IoT systems

CO3- Use IoT sensors and sensor networks for various application of IoT.

CO4- Apply various protocols to connect IoT related technologies to real time world.

CO5- Analyse and use different components of IoT for various applications.

Course Contents:

Unit 1

Fundamentals of IoT: Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M, Difference between IoT and M2M

Unit 2

IoT Reference Architecture- Getting Familiar with IoT Architecture, Reference Model of IoT, Various architectural views of IoT such as Functional, Information, Operational and Deployment. Constraints affecting design in IoT world- Introduction, Technical design Constraints. An emerging industrial structure for IoT.

Unit 3

Sensors Networks: Definition, Types of Sensors, Types of Actuators, Examples and Working, IoT Development Boards: Arduino IDE and Board Types, Raspberri Pi

Development Kit, RFID Principles and components, Wireless Sensor Networks: History and Context, the node, Connecting nodes, Networking Nodes, WSN and IoT.

Unit 4

Wireless Technologies for IoT: Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination. WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus.

IP Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols

Unit 5

Applications of IoT: Home Automation, Smart Cities, Energy, Agriculture, Health and Lifestyle, IoT in Environmental Protection.

Text Books/ Reference Books:

1. Hakima Chaouchi, ― "The Internet of Things Connecting Objects to the Web" ISBN : 978-1- 84821-140-7, Wiley Publications

2. Olivier Hersent, David Boswarthick, and Omar Elloumi, ― "The Internet of Things: Key Applications and Protocols", WileyPublications

3. Vijay Madisetti, Arshdeep Bahga, ― "Internet of Things (A Hands-on-Approach)", 1 st Edition, VPT, 2014.

4. J. Biron, J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.

5. Keysight Technologies, "The Internet of Things: Enabling Technologies and Solutions for Design and Test", Application Note, 2016.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc17_cs22/course

2. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PCC-RAI-602/21 CONTROL SYSTEMS

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Linear Algebra and Calculus, Ordinary Differential Equations and Multivariable Calculus, Laplace Transforms, Numerical Methods and Complex variables.

Successive: Advanced Control System, Control Systems Design, Digital Control Systems

Course Objectives:

The objectives of studying this course are: To understand the different ways of system representations such as Transfer function representation and state space representations and to assess the system dynamic response; To assess the system performance using time domain analysis; To assess the system performance using frequency domain analysis and techniques; and To design various controllers and compensators to improve system performance.

Course Outcomes (COs): At the end of the course, the student shall be able to:

- **CO1-** Understand the modeling of linear-time-invariant systems using transfer function and state- space representations.
- **CO2-** Design specifications for second order systems based on time response.
- **CO3-** Interpret the Concept of stability and its assessment for linear-time invariant systems using various methods.
- **CO4-** Design controllers in time and frequency domain.
- **CO5-** Explain the basic concept of optimal and nonlinear control systems.

Course Contents:

Unit 1

Introduction to control problem: Industrial Control examples, Mathematical models of physical systems, Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback, Transfer Function of control system, impulse response and its relation with transfer function of linear systems. Transfer function from Block diagram reduction technique and signal flow graph, Mason's gain formula. (8)

Unit 2

Time Response Analysis: Standard test signals, Time response of first and second order systems for standard test inputs, Application of initial and final value theorem, Design specifications for second-order systems based on the time-response. Concept of Stability, Routh-Hurwitz Criteria, Relative Stability analysis, Root-Locus technique, Construction of Root-loci. (6)

Unit 3

Frequency-response analysis: Relationship between time and frequency response, Polar plots, Bode plots, Nyquist stability criterion, Relative stability using Nyquist criterion – gain and phase margin, Closed-loop frequency response. (6)

Unit 4

Introduction to Controller Design: Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems, Root-loci method of feedback controller design, Design specifications in frequency-domain, Frequency-domain methods of design, Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs, Analog and Digital implementation of controllers. (10)

Unit 5

State Variable Analysis of Linear Dynamic Systems: State variables, State variable representation of system, dynamic equations, merits for higher order differential equations and solution, Concept of controllability and observability and techniques to test them. (4)

Unit 6

Introduction to Optimal Control and Nonlinear Control: Performance Indices, Regulator problem, Tracking Problem., Nonlinear system–Basic concepts and analysis. (5)

Text Books/ Reference Books:

1. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.

2. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.

3. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.

I. J. Nagrath and M.Gopal, "Control Systems Engineering", New Age International, 2009

Web Links: https://nptel.ac.in/courses/108/106/108106098/#

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PCC-RAI-603/21 SOFT COMPUTING

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

On successful complete of this course, the students should be able to:

1. To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.

2. To implement soft computing-based solutions for real-world problems.

3. To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.

Course Outcomes: At the end of the course, the student shall be able to:

- **CO1-** identify and describe soft computing techniques and their roles in building intelligent Machines.
- **CO2-** apply fuzzy logic and reasoning to handle uncertainty in engineering problems.
- **CO3-** apply genetic algorithms to solve combinatorial optimization problems.
- **CO4-** evaluate and compare solutions by various soft computing approaches for a given problem.

Course Contents:

Unit 1

Introduction to Soft Computing: Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics.

Unit 2

Fuzzy Logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy numbers, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making, Fuzziness of fuzzy sets, Fuzzy propositions.

Unit 3

Neural Networks: Basic characteristics of artificial neural networks, Perceptron model, Multilayer Perceptron model, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning,

Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks.

Unit 4

Genetic Algorithms: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning, Machine Learning Approach to Knowledge Acquisition.

Text Books/ Reference Books:

1. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", PHI Learning Private Limited.
2. Satish Kumar, "Neural Networks: A classroom approach" Tata McGraw Hill Education 1st Edition 2005
3. Haykin S., "Neural Networks-A Comprehensive Foundations", Pearson Education 2nd Edition.
4. Anderson J.A., "An Introduction to Neural Networks", MIT Press.
5. M.Ganesh, "Introduction to Fuzzy sets and Fuzzy Logic" PHI.
6. N.P. Padhy and S P Simon, "Soft Computing with MATLAB Programming", Oxford University Press 2015.
7. NPTEL course Introduction to Soft Computing, IIT Kharagpur, Prof. Debasis Samanta https://nptel.ac.in/courses/106105173

MCEVS-03 ENVIRONMENT POLLUTION, WASTE MANAGEMENT AND SANITATION

B. Tech (Robotics and Artificial Intelligence) VI Semester

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Outcomes (COs): At completion of this course, the learner will be able to:

CO1- Acquire the knowledge of sources, effects and control measures for environmental pollution/climate change at local and global level.

CO2- Gain insight into disaster management, environmental legislation and impact assessment.

CO3- Understand various concepts related to solid waste management and apply in solid waste management.

CO4- Analyze health and sanitation problems in the living environment and understand various social issues related to environment.

Course Contents:

Unit 1

Environmental Pollution and Climate Change: Definition - Causes: effects and control measure~ of: - Air Pollution, Water pollution, Soil Pollution, Marine pollution, Noise pollution, Thermal Pollution, Nuclear Hazards. Role of an individual in prevention of pollution. Case studies.

Climate Change: Causes, Consequences and Solution of Climate Change and its effect on: Agriculture, Availability of Fresh Water and Change of River Ecosystem, Sea-Level Rising and Loss of Human interest. IPCC Agenda 21, Earth Summit, Stockholm Conference 1972. Convention on Biological Diversity (CBD), Ramsar Convention. Kyoto Protocol, Montreal Protocol.

Unit 2

Disaster Management: Floods, Drought, Earthquake, Volcanoes, Cyclone and Landslides - their impacts. Disaster management cycle. Role of information, education communication and training in disaster management.

Environmental Legislation and EIA: Role of Ministry of Environment and Forest (MoEF), Government of India; Central Pollution Control Board (CPCB); National Environmental Policy (NEP) -2006, in developing legislation. Environment Protection Act. Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act., Issues involved in enforcement of Environmental legislation. Environmental Awareness: Role of Non-Government Organizations in Public Awareness. **Environment Impact Assessmcnt**: Concept and significance: methods of assessment.

Unit 3

Waste Management: Introduction to Solid waste management: Primary waste products - Solid waste, Toxic biological and hospital wastes; Waste composition and characterization. Municipal solid waste generation, cycling and disposal: landfills, incineration, source reduction and recycling, Hazardous waste management and handling rules.

Unit 4

Environmental Sanitation and Health: Introduction to WHO and UNICEF, water and airborne diseases: TB, Cholera. Amoebiasis, and Dehydration: ORT, social economic and health impacts of AIDS. Role of public awareness and information technology in sanitation and human health.

Social Issues and the Environment: From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, Rainwater Harvesting, Watershed management, Resettlement and rehabilitation of peoples; its problems and concerns, case studies. Environmental ethics: Issues and possible solutions. Environmental Education. Waste land reclamation, Consumerism and Waste products. Environmental movements: Chipko Movement.

Reference Books:

1. Solid Waste Management Manual CPCB, New Delhi .
2. Trivedy R.K. and Arvind Kumar, Eco technology for Pollution Control and Environmental Management
3. Sahai, Sushma (2009) Bio- medical waste management, APH Publishing.
4. Rao, M.N. and Sultana, R. (2012). Solid and Hazardous Waste Management, BS Publications, Hyderabad.
5. Canter, W. L. (I 995) Environmental Impact Assessment, McGraw-Hill Science/ Engineering/ Math, New York

6. Kulkarni, V. and Ramachandra, T.V. Environmental Management. Capital Pub. Co, New Delhi. 2006.
7. Glasson, J. Therivel, R. and Chadwick, A. Introduction to Environmental Impact Assessment. Routledge, London. 2006.
8. Sushmitha Bhaskar and R. Bhaskar, Natural Disasters, Unicorn Books, 2011.
9. Bohle, H. G., Downing, T. E. and Watts, M. J. Climate change and social vulnerability: the sociology and geography of food insecurity, Global Environmental Change. No.4, pp. 37-48.
I0. Kuka!, S. S., Kingra, P. K. (2019). Introduction to Environmental and Disaster Management, Kalyani Publishers.
11 .Kudrow, N. J. (2009). Conservation of Natural Resources. Nova Science Publishers, Incorporated
12. Anderson, D. A. (2013). Environmental economics and natural resource management. Routledge.

Suggested Web Sources:

1. http: //cnvisnic.in/l :NVIS html/l_NVISSubjcct/s ubjcct.html

2 https://nptel.ac.in/courses/103/106/103106162/

3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14

4. https://swayam.gov.in/

MC-04G MESSAGE OF BHAGAVAD GITA

B.Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits: 0
L T P Total
2 0 0 2

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: NIL
Successive: NIL

Course Objectives: To enable the students to create an awareness on message of Bhagavad Gita.
To instill moral, social values and to appreciate the Karma Yoga.

Course Outcomes (COs): After completing this course the **s**tudent should be able to:
CO1- Realize the relevance of Bhagavad Gita today.
CO2- Relate Yoga to Devotion
CO3-Realize the duties and Responsibilities in the Society.

Course Contents:

Unit1

Introduction: Relevance of Bhagavad Gita Today- Background of Mahabharata. Arjuna Vishada Yoga: Arjuna's Anguish and Confusion- Symbolism of Arjuna's Chariot. Sankhya Yoga: Importance of Self- knowledge- Deathlessness: Indestructibility of Counciousness- Being Established in Wisdom- Qualities of Sthita- Prajna.

Unit 2
Karma Yoga: Yoga of Action- Living in the Present- Dedicated Action without Anxiety over Results- Concept of Swadharma.

Dhyana Yoga: Tuning the Mind- Quantity, Quality and Direction of Thoughts- Reaching Inner Silence.

Unit 3
Bhakti Yoga: Yoga of Devotion- Form and Formless Aspects of the Divine- Inner Qualities of a True Devotee

Gunatraya Vibhaga Yoga: Dynamics of the Three Gunas: Tamas, Rajas, Sattava- Going Beyond the Three Gunas- Description of the Gunatheetha.

Recommended/ Reference Books:

1. Swami Chinmayananda, "The Holy Geeta", Central Chinmaya Mission Trust.

2. Swami Chinmayananda, “A Manual of Self Unfoldment”, Central Chinmaya Mission Trust.

PCC-RAI-604/21 IOT LAB

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			1	Sessional:	15 Marks
L	T	P	Total	Theory:	35 Marks
0	0	2	2	Total:	50 Marks
				Duration of Exam:	2 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The aim of this course is to familiarize students with the concept of IoT and Sensors for building various applications.

Course Outcomes: After the completion of this course, the students will be able to:

- **CO1-** Understand working and pin configuration of Arduino UNO Board and its installation.
- **CO2-** Install and Perform basic experiments using Raspberry Pi
- **CO3-** Use different types of sensors used in IoT for various applications.
- **CO4-** Interface Bluetooth with Arduino/Raspberry Pi and send sensor data to smartphone using Bluetooth

List of Experiments:

1. To Understanding Arduino UNO Board and Components
2. To Study Installation and work with Arduino IDE
3. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
4. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
5. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
6. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
7. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
8. Write a program to send data using HTTP protocol.
9. Write a program to send and receive data using MQTT protocol.
10. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
11. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
12. To study and interface PIR sensor with Arduino/Raspberry Pi and write a program for this.
13. To study different types of protocols used in IoT.

PCC-RAI-605/21 CONTROL SYSTEMS LAB

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			1	Sessional:	15 Marks
L	T	P	Total	Theory:	35 Marks
0	0	2	2	Total:	50 Marks
				Duration of Exam:	2 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The aim of this course is to apply the concepts of control system and to simulate and analyze the stability of the system in MATLAB.

Course Outcomes: At the end of the course, the student shall be able to:

- **CO1-** Design and investigate PID controller.
- **CO2-** To analyze the response of the closed and open loop systems using linear system simulator.
- **CO3-** To impart hands on experience to understand the performance of basic control system components such as temperature control, DC position control, potentiometric error detector, and synchro devices.
- **CO4-** Express the knowledge of MATLAB-SIMULINK to analyze system response by applying different inputs (step, ramp, pulse, etc)
- **CO5-** To analyze system stability using root locus, Nyquist plot, Bode diagram etc via MATLAB.

List of Experiments:

1. To design proportional-integral-derivative (PID) controller.
2. To study linear system simulator.
3. To study temperature control system.
4. To study DC position control system.
5. To study potentiometric error detector.
6. To study of synchro devices.
7. To plot of pole-zero plot of first order and second order transfer functions. Also simulate them to different inputs.
8. To study block diagram reduction method using MATLAB.
9. To plot root locus using MATLAB.
10. To plot Nyquist plot using MATLAB.
11. To plot Bode diagram using MATLAB.

Note: Some more experiments may also be conducted as per availability.

PCC-RAI-701/21 ADDITIVE MANUFACTURING

B. Tech (Robotics and Artificial Intelligence)

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives

The objectives of studying this course is to familiarize the students with the concept of additive manufacturing.

Course Outcomes: At the end of the course, the student shall be able to:

CO1- Familiarize students with 3D printing technology

CO2- Develop the ability to assess printing methods and materials for specific applications

CO3- Develop ability to design and 3D print complex devices/tools

CO4- Explore future applications and opportunities of 3D printing

CO5- Explore manufacturing considerations for 3D printed devices including quality control and FDA (for medical devices) issues

Course Contenta:

Unit 1

Introduction to Additive Manufacturing (AM): General overview Introduction to reverse engineering Traditional manufacturing vis AM Computer aided design (CAD) and manufacturing (CAM) and AM Different AM processes and relevant process physics AM process chain Application level: Direct processes – Rapid Prototyping, Rapid Tooling. Rapid Manufacturing; Indirect Processes - Indirect Prototyping. Indirect Tooling, Indirect Manufacturing

Unit 2

Materials Science for AM: Discussion on different materials used Use of multiple materials, multifunctional and graded materials in AM Role of solidification rate Evolution of non-equilibrium structure property relationship Grain structure and microstructure

Unit 3

AM Technologies: Powder-based AM processes involving sintering and melting (selective laser sintering, shaping, electron beam melting. involvement). Printing processes (droplet-based 3D Solid-based AM processes - extrusion based fused deposition modeling object Stereolithography Micro- and nano-additive

Unit 4

Mathematical Models for AM: Transport phenomena models: temperature, fluid flow and composition, buoyancy driven tension driven free surface flow pool) Case studies: Numerical Modeling of AM process, Powder bed melting based process, Droplet based printing process Residual stress, part fabrication time, cost, optimal orientation and optimal Defect in AM and role of transport Simulations (choice of parameter, Model validation.

Unit 5

Process Selection Planning, Control for AM: Selection of AM technologies using selection, decision methods Additive manufacturing process pl an: strategies and post processing. Monitoring and control of defects, transformation

Text Books/ Reference Books:

1. Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing Springer, 2010.

2. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

3. J.D. Majumdar and I. Manna, Laser-assisted fabrication of materials, Springer Series in Material Science, e-ISBN: 978-3-642- 28359-8.

4. L. Lu, J. Fuh and Y.-S. Wong, Laser-induced materials and processes for rapid prototyping, Kluwer Academic Press, 200 I.

5. Zhiqiang Fan and Frank Liou, Numerical modeling of the additive manufacturing (AM) processes of titanium alloy, lnTech, 2012.

6. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: principles and applications, 3rd Edition, World Scientific, 20 10.

PCC-RAI-702/21 DEEP LEARNING PRINCIPLES AND PRACTICES

B. Tech. (Robotics and Artificial Intelligence) VII Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Basics of Programming, Statistics, Calculus, Linear Algebra

Course Objectives:

The objective of studying this course is to

1. Build an understanding of the fundamental concepts of Deep Learning
2. Familiarize students with the neural networks and deep learning architecture
3. Introduce the concept of Classical Supervised Tasks with Deep Learning
4. Analyze real life applications and case studies of deep learning

Course Outcomes: At the end of the course, the student shall be able to:

CO1- Understand deep learning concepts

CO2- Explain Linear Classifiers, Linear Machines with Hinge Loss, Optimization Techniques, Gradient Descent, Batch Optimization

CO3- Discuss Neural Network, Multilayer Perceptron, Back Propagation Learning, Unsupervised Learning with Deep Network, Auto encoders, Describe Image Denoising, Semantics, Semantic Web and related problems.

CO4- Apply Deep learning techniques to solve real world problems

Course Contents:

Unit 1

Introduction to Deep Learning, Bayesian Learning, Decision Surfaces

Unit 2

Linear Classifiers, Linear Machines with Hinge Loss, Optimization Techniques, Gradient Descent, Batch Optimization

Unit 3

Introduction to Neural Network, Multilayer Perceptron, Back Propagation Learning, Unsupervised Learning with Deep Network, Auto encoders

Unit 4

Convolutional Neural Network, Building blocks of CNN, Transfer Learning, Revisiting Gradient Descent, Momentum Optimizer, Effective training in Deep Net- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization

Unit 5

Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, Fully Connected CNN etc.

Unit 6

Classical Supervised Tasks with Deep Learning, Image Denoising, Semantics, Segmentation, Object Detection etc.

Unit 7

Case Study of Deep Reinforcement Learning for Engineering Design: Application to Microfluidic Devices for Flow Sculpting, Integrating Deep Learning into CAD/CAE System: Case Study on Road Wheel Design Automation, Applications of Deep Learning & AI: optimize production floors, manufacturing supply chains; predict plant/unit failures, Reducing Test and Calibration Time

Text Books/ Reference Books:

1. Deep Learning, Ian Goodfellow, Yoshua Bengio and Aeron Courville, MIT Press, First Edition, 2016.
2. Deep Learning, A practitioner's approach, Adam Gibson and Josh Patterson, O'Reilly, First Edition, 2017.
3. Hands-On Learning with Scikit-Learn and Tensorflow, Aurelien Geron, O'Reilly, First Edition, 2017.
4. Deep Learning with Python, Francois Chollet, Manning Publications Co, First Edition, 2018.
5. Python Machine Learning by Example, Yuxi (Hayden) Liu, First Edition, 2017.
6. A Practical Guide to Training Restricted Boltzmann Machines, Geoffrey Hinton, 2010.
7. https://nptel.ac.in/courses/106106184
8. https://onlinecourses.nptel.ac.in/noc19_cs85/preview

PCC-RAI-703/21 MECHANICAL VIBRATIONS

B. Tech. (Robotics and Artificial Intelligence) VII Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Engineering Mechanics, Strength of Materials

Successive: Nil

Course Objectives:

- To study essential concepts for mechanical vibrations induced in various equipments.
- To study single degree of freedom, two degree of freedom system, vibration absorber and analyze effects of vibrations on mechanical equipment.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO1- Learn vibrations leading to analysis of first degree of freedom.

CO2- Understand two degree of vibration and vibration isolation and transmissibility.

CO3- Be Familiarized with multi degree of freedom systems using various numerical methods.

CO4- Understand the influence and stiffness coefficients.

CO5- Understand the transient vibrations.

Course Contents:

Unit 1

Introduction: Harmonic motion, periodic motion, vibration terminology.

Unit 2

Single Degree of freedom Systems: Free and forced vibrations with and without damping, magnification factor, transmissibility and isolation.

Unit 3

Two degree of Freedom Systems: Generalized co-ordinates, principal co-ordinates, derivation of equation of motion, co-ordinate coupling, Lagrange's equation.

Unit 4

Vibration Absorber: Tuned absorber, determination of mass ratio, tuned and damped absorber (qualitative treatment only), untuned viscous damper.

Unit 5

Multi Degree of Freedom system: Derivation of equation, calculation of natural frequencies by Rayleigh, Stodala, matrix, matrix iteration and Holzer methods.

Unit 6

Vibration Analysis: Introduction, Influence coefficient, Stiffness Matrix, Flexibility Matrix, Natural Frequencies and Normal Modes.

Unit 7

Transient Vibrations: Impulse Excitation, Arbitrary Excitation, Response to step Excitation, Base Excitation Solution by Laplace Transforms, Response Spectrum, Runge- kutta Method.

Text Books:

1. Mechanical Vibration: V.P.Singh, Dhanpat Rai & Sons.

2. Mechanical Vibration: G.K.Grover – Nem Chand & Bros., Roorkee, INDIA

Reference Books:

1. Thomson, W.T, “Theory of Vibration with Applications”, CBS Pub. & Distributors, 3rd Ed, 1988.

2. Tse, Morse and Hinkle, “Mechanical Vibration”, prentice Hall of India Ltd, 1987

3. Schaum Outline Series, “Mechanical Vibration”, Mc Graw Hill Book Company, 1990.

4. Lindley and Higgins, “Maintenance Engineering Hand Book” McGraw Hill Book Company, 1977.

Web Links:

S.No.	Address of Web Source	Contents
1	https://www.youtube.com/watch?v=hWNpID0TWYU	Basics of Vibration
2	https://www.youtube.com/watch?v=WaS3SmYutuo	Single degree of Freedom system

PCC-RAI-704/21 ADDITIVE MANUFACTURING LAB

B. Tech (Robotics and Artificial Intelligence) VII Semester

No. of Credits:			1	Sessional:	15 Marks
L	T	P	Total	Theory:	35 Marks
0	0	2	2	Total:	50 Marks
				Duration of Exam:	2 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives

The objectives of studying this course is to familiarize the students with the concept of additive manufacturing.

Course Outcomes: At the end of the course, the student shall be able to:

CO1- Familiarize students with 3D printing technology

CO2- Develop the ability to assess printing methods and materials for specific applications

CO3- Develop ability to design and 3D print complex devices/tools

CO4- Explore future applications and opportunities of 3D printing

List of Experiments:

1. Study of 3D printer as additive manufacturing tool
2. Study of extruder of 3D Printer
3. Generating STL files from the CAD Models & Working on STL files
4. Sending the tool path data for fabricating the physical part on 3D Printer
5. Evaluating the fabricated part for its suitability to a given application.
6. Cost analysis of AM parts
7. Modeling of Metal Parts in CAD Software
8. Fabrication of polymer-based parts
9. Production and characterization of additive manufactured components
10. Analysis of additive manufactured components by using 3D-microscope

PROFESSIONAL ELECTIVE COURSES

PEC-RAI-601/21 SOFTWARE ENGINEERING (PEC-I)

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Computer and Programming Fundamentals

Course Objectives:

1. To enable the students to apply a systematic application of scientific knowledge in creating and building cost effective software solutions to business and other types of problems. Students can understand different phases to make software & study them in detail.
2. To make the students understand project management concepts & their metrics. They are also familiar with the calculation of staffing for a particular project, its cost & schedule.
3. To make the students understand requirement engineering and its models (Information, functional, behavioral). Students are also aware about the design models & its principles (data design, component design, interface design & architectural design).
4. To make the students understand different testing techniques for different projects and to develop quality software ,its maintenance & introduce about software reliability.

Course Outcomes (COs):

CO1- Students will be able to understand basic concepts of software engineering, Software life cycle models.

CO2- Students will be able to calculate the cost & staff for a particular project at the start.

CO3- Students will be able to make an unambiguous SRS (software requirement specification) after collecting requirements of any client.

CO4- Apply various testing techniques to ensure the quality of software.

Unit 1

Introduction: Evolving role of software, Software Characteristics, Software crisis, Silver bullet, Software myths, Software process, Personal Software Process (PSP), Team Software Process (TSP), emergence of software engineering, Software process, project and product, Software Process Models: Waterfall Model, Prototype Model, Spiral, Model ,RAD Model, Iterative Model, Incremental Model, Aspect-oriented Model, Agile Model.

Unit 2

Software Project Management: Project management concepts, Planning the software project, Estimation—LOC based, FP based, Use-case based, empirical estimation COCOMO- A Heuristic estimation techniques, staffing level estimation, team structures, staffing, risk analysis and management.

Unit 3

Requirements, Analysis and specification: Software Requirements engineering, Requirement engineering process, Requirement Engineering Tasks, Types of requirements, SRS.

Unit 4

System Modeling: Data Modeling, Functional modeling and information flow: Data flow diagrams, Behavioral Modeling, The mechanics of structured analysis: Creating entity/ relationship diagram, data flow model, control flow model, the data dictionary.

Unit 5

System Design: Design principles, the design process; Design concepts: Abstraction, refinement, modularity, software architecture, control hierarchy, structural partitioning, data structure, software procedure, information hiding; Effective modular design: Functional independence, Cohesion, Coupling; Design Heuristics for effective modularity, Data Design, Architecture Design, Interface Design

Unit 6

Software Testing and Maintenance: Testing terminology—error, bug/defect/fault, failure, Verification and validation, Test case design, Static testing ,Dynamic testing--- Black box testing—Boundary value analysis, White box testing-- basis path testing, Unit testing,

Integration testing, Acceptance Testing, debugging, debugging process debugging approaches. Software maintenance categories, Models

Unit 7

Software Quality Models and Standards: Quality concepts, Software quality assurance, SQA activities, Formal approaches to SQA; Statistical software quality assurance; CMM, The ISO 9126 Standard

Unit 8

Advanced topics in Software Engineering: Configuration Management, Software re-engineering, reverse engineering, restructuring, forward engineering, and Clean Room software engineering.

Case Study: To develop SRS and SDD for a Software Project.

Text / Reference Books:

1. Software Engineering – A Practitioner's Approach, Roger S. Pressman, MGH.
2. Fundamentals of software Engineering, Rajib Mall, PHI.
3. Software Engineering by Ian Sommerville, Pearson.
4. Software Engineering – David Gustafson,T.M.H
5. Software Engineering Fundamentals Oxford University, Ali Behforooz and Frederick J. Hudson, JW&S.
6. An Integrated Approach to software engineering by Pankaj jalote, Narosa.
7. Software Testing: Principles and Practices, Dr. Naresh Chauhan, OxFord Press.

PEC-RAI-602/21 OPERATING SYSTEM (PEC-I)

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre-requisites: Fundamentals of Computers.

Course Objectives:

1. To learn the fundamentals of Operating Systems.
2. To learn the mechanisms of OS to handle processes, threads, and their communication.
3. To know the components and management aspects of concurrency management viz. Mutual exclusion algorithms, deadlock detection algorithms and agreement protocols.
4. To learn the mechanisms involved in memory management and Input/Output management aspects of Operating systems.

Course Outcomes (COs): After the completion of the course, the students will be able to:

CO1- Learn the basic concepts of operating system, its various types and architecture

CO2- Learn and implement process management issues including process life cycle, scheduling, synchronization, and deadlocks

CO3- Learn and implement memory management issues including memory partitioning, memory allocation and virtual memory concept

CO4- Learn and implement files systems and I/O systems including file management, disk management and kernel I/O subsystems

Course Contents:

Unit 1

Introduction: Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. Case study on UNIX and WINDOWS Operating System.

Unit 2

Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching

Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads, **Process Scheduling**: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting

Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF.

Unit 3

Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer/Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.

Unit 4

Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.

Unit 5

Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation – Hardware support forpaging, Protection and sharing, Disadvantages of paging.
Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault , Working Set , Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).

Unit 6

I/O Hardware: I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, Secondary-Storage Structure: Disk structure, Disk scheduling algorithms
File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance.
Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks

Text Books/ Reference Books:

1. Abraham Silberschatz, Peter Galvin, Greg Gagne, *"Operating System Concepts Essentials*", 9th Edition, Wiley Asia Student Edition.
2. Naresh Chauhan," Principles of Operating System", 2014, OxFord Press.

PEC-RAI-603/21 THEORY OF OPTIMIZATION TECHNIQUES (PEC-I)

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Course Objectives:

The objective of this course is

1. To provide insight to the mathematical formulation of real- world problems.
2. To optimize these mathematical problems using nature- based algorithms. And the solution is useful, especially for NP-Hard problems.
3. To solve various constrained and unconstrained problems in Single variable as well as multivariable.
4. To apply the methods of optimization in real life situations.

Course Outcomes:

After completion of course, students would be able to:

1. Apply basic concepts of mathematics to formulate an optimization problem
2. Understand and apply the concept of optimality criteria for various types of optimization problems.
3. Solve various constrained and unconstrained problems in Single variable as well as multivariable.
4. Apply the methods of optimization in real life situations.

MODULE-1:

Engineering applications of optimization, Formulation of design problems as mathematical programming problems.

MODULE-2:

General Structure of Optimization Algorithms, Constraints, The Feasible Region.

MODULE-3:

Branches of Mathematical Programming: Optimization using calculus, Graphical Optimization, Linear Programming, Quadratic Programming, Integer Programming, Semi Definite Programming.

MODULE-4:

Optimization Algorithms like Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc.

MODULE-5:

Real life Problems and their mathematical formulation as standard programming problems.

REFERENCES

1. Laurence A. Wolsey, "Integer programming". Wiley. ISBN 978-0-471-28366-9.
2. John K. Karlof (2006), "Integer programming: theory and practice". CRC Press. ISBN 978-0-8493-1914-3.
3. H. Paul Williams (2009), "Logic and Integer Programming". Springer. ISBN 978-0-387-92279-9.
4. Michael Jünger; Thomas M. Liebling; Denis Naddef; George Nemhauser; William R. Pulleyblank; Gerhard Reinelt; Giovanni Rinaldi; Laurence A. Wolsey, eds. (2009), "50 Years of Integer Programming". 1958-2008: From the Early Years to the State-of- the- Art. Springer. ISBN 978-3-540-68274-5.
5. Der-San Chen; Robert G. Batson; Yu Dang (2010), "Applied Integer Programming: Modeling and Solution". John Wiley and Sons. ISBN 978-0-470-37306-4.

PEC/RAI/604/21 CLOUD COMPUTING (PEC-I)

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Operating System

Successive: None

Course Objectives:

1. To provide comprehensive knowledge of fundamental concepts and of cloud computing
2. To provide an understanding of various web technologies used in cloud and understanding of concept of Virtualization and its types.
3. To understand various databases in cloud along with the programming models involved in Cloud Computing.
4. To learn various aspects of security in cloud and understand the issues regarding QOS, Dependability, data migration, streaming.

Course Outcomes:

Upon successful completion of the course, the students will be able to

1. Articulate the fundamental concepts of Cloud Computing along with service and deployment models.
2. Utilize various web technologies used in cloud and understand concept of Virtualization.
3. Understand various programming aspects of Cloud.
4. Identify security aspects of different models and manage the cloud.

Unit-I **INTRODUCTION TO CLOUD COMPUTING**: Definition, Characteristics, and Components, Cloud provider, SAAS, PAAS, IAAS and others. Organizational scenarios of clouds, Administering & Monitoring cloud services, benefits and limitations. Cloud computing platforms: Infrastructure as service: Amazon EC2, Platform as Service: Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing

Unit-II **INTRODUCTION TO CLOUD TECHNOLOGIES**: Compare SOAP and REST Web services, AJAX and Mashups-Web services, SOAP versus REST, AJAX: asynchronous 'rich' interfaces, Mashups: user interface services. **Virtualization:** Study of Hypervisors, Virtualization at the infrastructure level, CPU Virtualization, Storage Virtualization.

Unit-III **DATA INTENSIVE COMPUTING**: Relational databases, Parallel Computing, BigTable, HBase and Dynamo, MapReduce Programming, MapReduce Programming Model and its efficiency. Relational operations using Map-Reduce, Enterprise batch processing using Map-Reduce. Example/Application of MapReduce in cloud. Map-Reduce model. Cloud file systems: GFS and HDFS, Features and comparisons among GFS, HDFS etc.

Unit-IV **CLOUD SECURITY FUNDAMENTALS & QUALITY ISSUES**: Privacy and Security in cloud. Cloud computing security architecture: - General Issues, Trusted Cloud computing, Microarchitectures: Identity Management and Access control, Autonomic Security. Cloud computing security challenges: infrastructure Security: The Network Level, The Host Level, The Application Level, Aspects of Data Security. QOS Issues and monitoring in Cloud, Dependability, data migration, load balancing, resource optimization, resource dynamic reconfiguration, Monitoring in Cloud. **Audit and Compliance:** Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Regulatory/External Compliance, Cloud Security Alliance, Auditing the Cloud for Compliance, Security-as-a-Cloud.

Text / Reference Books:

1. Gautam Shroff, ―Enterprise Cloud Computing Technology Architecture Applications‖, Cambridge University Press, [ISBN: 978-0521137355].
2. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, ―Distributed and Cloud Computing: From parallel processing to IOT‖ Morgan Kaufmann Publishers; 1 edition [ISBN: 978-0-12-385880].
3. Cloud Computing by Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper (Wiley India Edition)
4. Cloud Security & Privacy by Tim Malhar, S.Kumaraswammy, S.Latif (SPD,O'REILLY)
5. Cloud Computing: A Practical Approach, Antohy T Velte, et.al McGraw Hill,
1. Cloud Computing Bible by Barrie Sosinsky, Wiley India

PEC-RAI-611/21 MOBILE COMMUNICATION NETWORK (PEC-II)

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Course Objectives:

- To introduce working principles of mobile communication system.
- To introduce various technologies of mobile communication.
- To introduce various analysis techniques of communication systems.
- To introduce various multiple access techniques for mobile communication.

Syllabus

Unit 1: Cellular concepts: Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, and power control, Wireless Standards, Overview of 2G and 3G cellular standards.

Unit 2: Signal propagation: Propagation mechanism, reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Fading channels-Multipath and small scale fading, Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate.

Unit 3: Multiple access schemes: FDMA, TDMA, CDMA and SDMA, Modulation schemes, BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM.

Unit 4: Receiver structure: Diversity receivers, selection and MRC receivers, RAKE receiver, equalization, linear-ZFE and adaptive, DFE, Transmit diversity-Altamonte scheme.

Unit 5: MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing tradeoff, Performance measures, Outage, average snr, average symbol/bit error rate. System examples, GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA.

Course Outcomes: On successful completion of this course, the students should be able to:

- Understand the working principles of the mobile communication systems.
- Understand the relation between the user features and underlying technology.
- Analyze mobile communication systems for improved performance.
- Understand various multiple access techniques.

Text/Reference Books:

1. WCY Lee, Mobile Cellular Telecommunications Systems, McGraw Hill, 1990.
2. WCY Lee, Mobile Communications Design Fundamentals, Prentice Hall, 1993.
3. Raymond Steele, Mobile Radio Communications, IEEE Press, New York, 1992.
4. AJ Viterbi, CDMA: Principles of Spread Spectrum Communications, Addison Wesley, 1995.
5. VK Garg &JE Wilkes, Wireless & Personal Communication Systems, Prentice Hall, 1996.

PEC-RAI-612/21 WIRELESS COMMUNICATION (PEC-II)

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Course Objectives:

1. To provide an overview of Wireless Communication networks area and its applicationsand examples of wireless communication devices.
2. To understand the various terminology, principles, devices, schemes, concepts, algorithms and different methodologies used in Wireless Communication Networks.
3. Distinguish the major cellular communication standards (1G/2G/3G systems) and introduce various wireless systems and standards such as GSM and their basic operationcases. It also deals with second generation and third generation wireless networks.
4. It provides idea about the different spectrum allocation techniques
5. It provides the need of intelligent cell concept, applications of intelligent micro cellsystems and how this is applied in in-building communication.

Unit-1: Introduction to Wireless Communication System: Evolution of mobile radio communications, examples of wireless communication systems, paging systems, Cordlesstelephone systems, comparison of various wireless systems.

Unit-2: Modern Wireless Communication System: Second generation cellular networks: GSM, third generation wireless networks: CDMA, Introduction to 4G wireless networks wirelessin local loop, wireless local area networks, Blue tooth and Personal Area Networks.

Unit-3: Introduction to Cellular Mobile Systems: Spectrum Allocation, Basic cellular Systems, performance criteria, Operation of Cellular systems, Analog cellular systems, Digitalcellular systems.

Unit-4: Cellular System Design Fundamentals: Frequency Reuse, channel assignment strategies, hand off strategies (MAHO, MCHO, NCHO), Interference and system capacity,

Tracking and grade off service, improving coverage and capacity: Cell splitting, Cell sectoring,Zone concepts.

Unit-5: Multiple Access Techniques for Wireless Communication: Introduction to Multiple Access, FDMA, TDMA, spread Spectrum multiple Access, space division multiple access, packet ratio, capacity of a cellular systems.

Unit-6: Wireless Networking: Difference between wireless and fixed telephone networks, development of wireless networks, fixed network transmission hierarchy,

traffic routing in wireless network, wireless data services, common channel signaling, ISDN (Integrated ServiceDigital Networks), Advanced Intelligent Networks.

Unit-7: Intelligent Cell Concept and Application: Intelligent cell concept, applications ofintelligent micro cell systems, in-building communication.

Course Learning Outcomes:

A student who successfully completes Wireless Communications will

a) Understand the basics of wireless communication networks.

b) Knowledge about overall GSM cellular concept along with Cellular systems from 1G to 3G,

Wireless 4G systems

c) Fundamentals of cellular communications as Hexagonal cell geometry, Co-channelinterference, Cellular system design, Sectoring using directional antennas

d) Knowledge of different spread spectrum techniques.

e) Have an understanding about how intelligent cell concept is useful in in-building-communication.

PEC-RAI-613/21 WIRELESS SENSOR NETWORKS(PEC-II)

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Course Objectives:

- To introduce designing of wireless sensor network applications.
- To introduce various research areas in wireless sensor networks.
- To introduce various MAC protocol used in WSN.
- To teach students how to explore new protocols for WSN.

Unit 1: Introduction to Sensor Networks, unique constraints and challenges, Advantage of SensorNetworks, Applications of Sensor Networks, Types of wireless sensor networks.

Unit 2: Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Networks, Enabling technologiesfor Wireless Sensor Networks. Issues and challenges in wireless sensor networks.

Unit 3: Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee.

Unit 4: Dissemination protocol for large sensor network, Data dissemination, data gathering, and datafusion; Quality of a sensor network; Real-time traffic support.

Unit 5: Design Principles for WSNs, Gateway Concepts, Need for gateway, WSN to Internet Communication, and Internet to WSN Communication.

Unit 6: Single-node architecture, Hardware components & design constraints, Operating systems andexecution environments, introduction to TinyOS and nesC.

Course Outcomes: **On successful completion of this course, the students should be able to:**

- Design wireless sensor networks for a given application
- Understand emerging research areas in the field of sensor networks
- Understand MAC protocols used for different communication standards used in WSN
- Explore new protocols for WSN

Text/Reference Books:

1. Waltenegus Dargie , Christian Poellabauer, “Fundamentals Of Wireless Sensor NetworksTheory And Practice”, By John Wiley & Sons Publications ,2011
2. Sabrie Soloman, “Sensors Handbook" by McGraw Hill publication. 2009

3. Feng Zhao, Leonidas Guibas, “Wireless Sensor Networks”, Elsevier Publications,2004
4. Kazem Sohrby, Daniel Minoli, “Wireless Sensor Networks”: Technology, Protocols andApplications, Wiley-Inter science
5. Philip Levis, And David Gay "TinyOS Programming” by Cambridge University Press 2009

PEC-RAI-614/21 SMART SENSORS AND SENSOR NETWORKS (PEC-II)

B. Tech. (Robotics and Artificial Intelligence) VI Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Course Objectives:

1. Understand the basic WSN technology and supporting protocols,
2. Understand the different sensor network stack in terms of layers and their role, operations and challenges,
3. Understand and appreciate sensor fusion and data aggregation techniques as means for achieving accurate sensing and efficient data capture and transport,

UNIT 1: Introduction and Applications: Introduction to smart sensors, Application domains of sensor networks. Enabling technologies: hardware/software platforms, Performance metrics.

UNIT 2: Communication Model: Wireless sensor network architecture, wireless sensor node architecture, and protocol stack Stack layers, roles and challenges, Network capacity.

UNIT 3: Routing protocols: Data centric-protocols, gossiping, Rumor routing, directed diffusion. Hierarchical protocols: LEACH, Location-based (Geographical) protocols and energy-aware routing: GPSR, distributed topology routing (PRADA), Multipath-routing.

UNIT 4: Localization and Synchronization: Global location (GPS-based) and relative location (Beacon-based). Localization methods: anchor-free, anchor-based, range-free, range-based. Timing/synchronization Coverage and connectivity: properties and quality aspects.

UNIT 5: Sensor Fusion with Compressive sensing: Sensor fusion paradigms, Sampling theory Compressible signals, Sensing matrix design, Signal recovery.

Course Outcomes:- On successful completion of this course, the students should be able to:

1. The students will learn how such constraints make the design and operation of sensor networks considerably different from contemporary wireless networks.
2. They will learn the importance of resource conscious protocols and management techniques.
3. Understand the importance of sensor localization and synchronization
4. Learn key routing protocols for sensor networks.

Reference Books

● Anna Hac, "Wireless Sensor Network Designs," John Wiley & Sons, December 2003, 391 pages.

● Edgar H. Callaway, Jr. and Edgar H. Callaway, "Wireless Sensor Networks: Architectures and Protocols," CRC Press, August 2003, 352 pages.

PEC-RAI-701/21 OPERATIONS RESEARCH (PEC-III)
B. Tech. (Robotics and Artificial Intelligence) VII Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

To develop decision making capabilities of the students by analyzing different situations within an environment involving limited resources and constraints thereby finding the optimal solution.

Course Outcomes: At the end of the course, the student shall be able to:

CO1 Understand the role of operations research in decision-making, and its applications in industry and able to formulate and design real-world problems through models & experiments.
CO2 Knowledge of various types of deterministic models like linear programming, transportation model and ability to solve real world problems.
CO3 Understand and apply various types of stochastic models like waiting line model, project line model, simulation in real world situations.
CO4 Deduce the relationship between a linear program and it's dual and perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
CO5 Describe different decision-making environments and apply decision making process in the existent and futuristic state of affairs.

Course Contents:

Unit 1:

Introduction: Definition, History of Operations Research, role of operations research in decision-making, applications in industry. Concept on O.R. model building –Types & methods. (2)

Unit 2:

Programming (LP): Programming definition, formulation, solution- graphical, simplex, BIG-M methods, Duality, PRIMAL-DUAL relations-its solution, shadow price, economic interpretation, dual-simplex, post-optimality & sensitivity analysis, problems. (10)

Unit 3:

Deterministic Model: Transportation model-balanced & unbalanced, north west rule, Vogel's Method, least cost or matrix minimal, Stepping stone method, MODI methods, degeneracy, assignment, travelling salesman, problems. (8)

Unit 4:

Waiting Line Models: Introduction, queue parameters, M/M/1 queue, performance of queuing systems, applications in industries, problems. (6)

Unit 5:

Project Line Models: Network diagram, event, activity, defects in network, PERT & CPM, float in network, variance and probability of completion time, project cost- direct, indirect, total, Introduction to crashing of network & resources levelling in project, problems. (8)

Unit 6:

Simulation and Decision Theory: Introduction, design of simulation, models & experiments, model validation, process generation, time flow mechanism, Monte Carlo methods- its applications in industries, Decision process, SIMON model, types of decision-making environment - certainty, risk, uncertainty, decision making with utilities, problems. (6)

Note: Concerned software's may be used to solve OR problems.

Text Books/ Reference Books:

1. Operations Research – Hamdy A. Taha, Pearson Education.

2. Quantitative Techniques in Management – N.D. Vohra, TMH, New Delhi

3. Operations Research – J.K. Sharma, Trinity Press

4. Operations Research – Ravindran, Phillips, Solberg, Wiley Student Edition.

5. Principles of Operation Research – H.M. Wagner, Prentice Hall of India, New Delhi.

6. Introductory Operations Research – H.S. Kasana, K.D. Kumar, Springer

Web Links:

S. No.	Address of web source	Content
1.	http://nptel.ac.in/courses/112106134/	Unit 2 and 3
2.	http://nptel.ac.in/courses/112106131/	Unit 4 and 5

PEC-RAI-702/21 DESIGN OPTIMIZATION (PEC-III)
B. Tech. (Robotics and Artificial Intelligence) VII Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The objective of studying this course is to understand the concepts of optimization and apply to optimize mechanical system design.

Course Outcomes: At the end of the course, the student shall be able to:

CO1 Understand the basic concepts of design optimization.

CO2 Analyse different approaches for optimization.

CO3 Learn different optimization techniques.

CO4 Simulate mechanical system as per design standards.

CO5 Apply optimization in mechanical design.

Course Contents:

Unit 1:

Introduction to Optimum design: Introduction to detail design optimization by simulation, prototyping and optimum. Selection of configuration, materials and processes. (8)

Unit 2:

Optimization Approach: Classical mathematical methods of optimization. Mechanical System Design problem-economic political environment, issues of human safety & welfare, and professional ethics. Optimum mechanical design concepts. (8)

Unit 3:

Overview and application of optimization methods to machine elements and mechanical system design. Prototyping, simulation, and use of standards for detail design optimization. (8)

Unit 4:

Optimization Techniques: Optimum selection of material & processes in mechanical design using material selection charts and optimization methods. (8)

Unit 5:

Applications: Optimizing product design functionality, aesthetics and economics by employing industrial design principles and by suitable selection of material & processing including use of polymers, composites and other non-metallic materials. (8)

Text Books/ Reference Books:

1. H. Adeli. Advances in Design Optimization.

2. Robert F. Rhyder, Manufacturing Process Design and Optimization, New York: Marcel Dekker.

3. S.S. Rao, Optimization: Theory & Application Wiley Eastern

4. K. Deb, Optimization for Engineering Design, Prentice Hall India

5. J.S. Arora, Introduction to Optimum Design, McGraw Hill

Web Links:

https://nptel.ac.in/courses/105108127

https://nptel.ac.in/courses/108105019

https://home.iitk.ac.in/~dasgupta/teaching/optim/

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PEC-RAI-703/21 PRODUCT DESIGN AND DEVELOPMENT (PEC-III)
B. Tech. (Robotics and Artificial Intelligence) VII Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

To study essential concepts of product design and development. To design components for manufacture in industries, industrial design process and its management, product design methods, product specifications and product development.

Course Outcomes: At the end of the course, the student shall be able to:

CO1 Understand the basics of product development.

CO2 Conceptualize product as per customer needs and plan product development process.

CO3 Apply techniques for conversion of customer requirements into product design processes.

CO4 Devise suitable methods for product manufacturing.

CO5 Optimize product economics as per industrial perspective.

Course Contents:

Unit 1:

Introduction: Design theory, design materials, human factors in design, man-machine system, applied ergonomics, characteristics of successful product development, challenges to product development. (6)

Unit 2:

Development process and product planning: Generic development process, Concept development, product development process flows, product planning process, identify customer needs. (6)

Unit 3:

Product specifications and concept generation: Product specification, steps to establish the target specifications, Concept generation, five step concept generation method, concept selection, concept screening, concept testing, product architecture. (8)

Unit 4:

Product design methods: Creative and rational, clarifying objectives - the objective tree method, establishing functions- the function analysis method, setting requirements – the performance specification method, determining characteristics – the QFD method, generating

alternatives – morphological chart method, evaluating alternatives – the weighted objective method, improving details – the value engineering method and design strategies. (8)

Unit 5:

Design for manufacture: Estimating manufacturing cost, reducing component, assembly and support costs, design for assembly, design for disassembly, design for environment, design for graphics and packaging, Basics and principles of prototyping, prototyping technologies, planning for prototypes. (8)

Unit 6:

Industrial design: Its need, impact and quality, industrial design process and its management, legal issues in product design, design resources, economics and management of product development projects. (4)

Text Books/ Reference Books:

1. K.T. Ulrich and S.D. Eppinger, "Product design and development", Tata McGraw Hill

2. Chitale & Gupta, "Product Development", Tata McGraw Hill

3. Monks, J. G., "Operations Management", McGraw Hill, 1997.

4. George Dietor, A material and Processing approach, McGraw Hill

Web Links:

https://ocw.mit.edu/courses/15-783j-product-design-and-development-spring-2006/pages/lecture-notes/

https://nptel.ac.in/courses/112107217

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PEC-RAI-704/21 TOTAL QUALITY MANAGEMENT(PEC-III)
B. Tech. (Robotics and Artificial Intelligence) VII Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

To facilitate the understanding of total quality management principles and processes.

Course Outcomes: At the end of the course, the student shall be able to:

CO1 Understand quality and dimensions related to quality management.

CO2 Use the tools and techniques of TQM in manufacturing and service sectors.

CO3 Measure quality performance of the manufacturing systems.

CO4 Learn various aspects of quality systems of national and international bodies.

Course Contents:

Unit 1:

Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality. (8)

Unit 2:

TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection. (8)

Unit 3:

The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types. (8)

Unit 4:

TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures. (8)

Unit 5:

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation; Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors. (8)

Text Books/ Reference Books:

1. Besterfield D.H. et al., Total Quality Management, 3rd ed., Pearson Education Asia, 2006.

2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.

3. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.

4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

Web Links:

https://nptel.ac.in/courses/110104080

https://nptel.ac.in/courses/110104085

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PEC-RAI-705/21 OPERATIONS MANAGEMENT (PEC-III)
B. Tech. (Robotics and Artificial Intelligence) VII Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The objective of studying this course is to develop operational skills in problem resolving, planning, project management, quality management, inventory management, communication, and work strategically and effectively in production and related industries.

Course Outcomes: At the end of the course, the student shall be able to:

CO1 Understand the concept of operations management and its role in enhancement of productivity.

CO2 Evaluate various facility alternatives and layout for operational suitability.

CO3 Utilize production planning and project scheduling in operation environments.

CO4 Plan and implement suitable quality control measures in operations.

CO5 Plan and implement resource management and waste reduction techniques.

Course Contents:

Unit 1:

Introduction to Operations Management, Functions and Challenges, Operations Strategy, Product Life – Cycle, Production System, Types of production system, Value Engineering Concepts. (8)

Unit 2:

Sales Forecasting, Forecasting System, Qualitative and Quantitative Methods of Forecasting, Facility Planning, Plant Location, Factors Affecting Plant Location, Facility Layout and Planning, Factors Influencing Plant Layout, Production Planning and Control, Process Planning, Aggregate Production Planning. (8)

Unit 3:

Project Scheduling, Network Diagrams, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), CPM and PERT Problems. (8)

Unit 4:

Sequencing, Sequencing Problems, Master Production Scheduling (MPS), Concept of Quality, Total Quality Management (TQM), Total Productive Maintenance (TPM), Statistical Quality Control (SQC), Six Sigma, Supply Chain Management. (8)

Unit 5:

Materials Management, Inventory Control, Economic Order Quantity (EOQ) Models, EOQ Problems, Production Quantity Model; Just in Time (JIT), Kanban System, Materials Requirement Planning (MRP)-I, Materials Requirement Planning (MRP)-II, Enterprise Resource Planning (ERP). (8)

Text Books/ Reference Books:

1. Operations Management: B. Mahadevan, Pearson Education

2. Operation Management: K. N. Dervitsiotis, McGraw-Hill International Company.

3. Operations Management: R.S. Russell, and B.W. Taylor, Pearson Education

4.Industrial Engineering and Production Management: M. Telsang, S. Chand & Company Ltd.

5. Richard B. Chase, Ravi Shankar and F. Robert Jacobs (2014); Operations & Supply Chain Management; McGraw-Hill.

6. Chary S. N. Theory and Problems in Production & Operations Management; Tata McGraw Hill.

Web Links:

https://nptel.ac.in/courses/112107238

https://nptel.ac.in/courses/110107141

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PEC-RAI-706/21 VALUE ENGINEERING (PEC-III)
B. Tech. (Robotics and Artificial Intelligence) VII Semester

No. of Credits:			3	Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The objective of the course is to acquaint the students with Value Engineering approach towards design and development of a product.

Course Outcomes: At the end of the course, the student shall be able to:

CO1 Understand and apply the concepts of value engineering & its phases.

CO2 Select the project for value engineering.

CO3 Analyze the functional approach of product.

CO4 Evaluate the worthiness of a product.

CO5 Utilize the value engineering tools and techniques.

Course Contents:

Unit 1:

Introduction to Value engineering (history, concept and definitions), advantages, applications, Value Engineering vs. Cost cutting, Phases in Value Engineering. (6)

Unit 2:

Introduction to Product Design and Development, Product Design Steps and Product Analysis, Profit Consideration, Selection and Evaluation of value engineering Projects, Project selection, methods selection, value standards, application of value engineering methodology. (10)

Unit 3:

Anatomy of the function, classifying function, basic vs. secondary vs. unnecessary functions, Types of Product Functions, Functional Analysis, Functional Analysis System Technique (FAST). (8)

Unit 4:

Function-Cost Relationship, evaluation of costs, evaluation of worth, determining worth, evaluation of value. Applications in Product Design, Value Engineering Case Study. (8)

Unit 5:

VE Tools and Techniques, selecting products and operation for value engineering action, developing alternate means to required functions, reporting results, Follow up. Success Stories. (8)

Text Books/ Reference Books:

1. Lawrence D. Miles; “Techniques of Value Analysis and Engineering”, 2nd Edition, McGraw-Hill Book Company, Inc. New York.
2. Larry W. Zimmerman, Glen D. Hart; “Value Engineering”, Reprint 1999, CBS Publishers and Distributors, New Delhi
3. A. K. Chitale and R. C. Gupta, “Product Design and Manufacturing”, 3rd Edition, Prentice-Hall of India.
4. Anil Kumar Mukhopadhyaya, “Value Engineering: Concepts Techniques and applications”, SAGE Publications 2010.

Web Links:

https://nptel.ac.in/courses/112107282

Note: It is recommended that some part of the syllabus is to be covered in online mode.

PEC-RAI-711/21 METALLURGY (PEC-IV)
B. Tech (Robotics and Artificial Intelligence) VII Semester

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Pre- Requisite: Materials Engineering

Successive: Nil

Course Objectives

The objective of this course is to provide students a deep insight of various metallurgical phenomena alongwith the properties of different engineering materials and characterisation techniques.

Course out Comes (COs): At the end of the course, the student shall be able to:

- **CO 1:** Understand the fundamentals of solidification process and grain growth
- **CO 2:** Describe Diffusion in solids and elements of grain boundaries
- **CO 3:** Explain Precipitation in metallic alloys
- **CO 4:** Discuss the properties and application of various engineering materials
- **CO 5:** Analyze materials using metallography and characterization techniques

Unit 1

Solidification of Metals: The liquid phase, nucleation, crystal growth from the liquid phase, the heats of fusion and vaporization, the nature of the liquid-solid interface, continuous growth, lateral growth, stable interface freezing, dendritic growth in pure metals, freezing in alloys with planar interface, the Scheilequation. **(6)**

Unit 2

Diffusion in solids: Introduction to diffusion in solids, Fick's 1st and 2nd law, diffusion mechanisms, steady-state diffusion, non steady-state diffusion, factors that influence diffusion.

Elements of Grain Boundaries: Grain boundaries, types of grain boundaries, the five degrees of freedom of a grain boundary, boundaries between crystals of different phases, the grain size, the effect of grain boundaries on mechanical properties, Hall-Petch relation**. (8)**

Unit 3

Precipitation hardening in alloys: Introduction and significance of the solvus curve, solution and aging treatments, development of precipitates, aging and precipitation sequences of binary and ternary aluminium alloys, homogeneous versus heterogeneous nucleation of precipitates, interphase precipitation, theories of hardening, additional factors in precipitation hardening **(6)**

Unit 4

Conventional and advanced Engineering Materials: Alloying of steel, properties of stainless steel and tool steels, maraging steels, copper and copper alloys, cupronickel, aluminium and its alloys, nickel based superalloys and titanium alloys, graphene, carbon nanotubes (CNT), buckminsterfullerene (C60), introduction to smart materials and their applications. **(10)**

Unit 5

Metallography and Characterization Techniques: Introduction, metallurgical microscope, preparation of specimen, micro and macro examination, the Bragg law, Laue techniques, the rotating-crystalmethod,the Debye-Scherrer or powder method, the x-raydiffractometer (XRD), scanning electron microscope (SEM) and its working principle, transmission electron microscope (TEM) and its working principle. **(10)**

Recommended/ Reference Books:

1. Material Science and Engineering-An Introduction: Callister, W.D., John Wiley & Sons, Delhi
2. Physical Metallurgy Principles- by Reza Abbaschian, Lara Abbaschian and Robert E. Reed-Hill - Cengage Learning
3. Engineering Materials: Kenneth G. Budinski, Prentice Hall of India, New Delhi
4. Engineering Metallurgy (Part I: Applied Physical Metallurgy): Raymond A. Higgins, Arnold Publishers
5. Physical Metallurgy, 4th ed. Vol.1:Robert W. Cahn, Peter Haasen, North-Holland Publishers
6. Physical Methods for Materials Characterisation: P E J Flewitt, R K Wild, Institute of Physics Publishing

Weblinks:

1. https://nptel.ac.in/courses/115/103/115103030/
2. https://nptel.ac.in/courses/113/106/113106034/
3. https://nptel.ac.in/courses/113/102/113102080/
4. https://nptel.ac.in/courses/112/108/112108150/
5. https://nptel.ac.in/courses/113/106/113106032/
6. https://nptel.ac.in/courses/113/105/113105023/

PEC-RAI-712/21 COMPOSITE MATERIALS (PEC-IV)

B. Tech (Robotics and Artificial Intelligence) VII Semester

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Materials Engineering

Successive: Manufacturing Technology

Course Objectives:

The objective of this course is to provide the students an understanding of composite materials along with their processing methods and mechanical behavior.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1-Classify composite materials and describe their mechanical behavior.

CO 2-Describe manufacturing techniques of composite materials.

CO 3-Determine stresses in composite laminates based on various theories of failures.

CO 4-Analyze the laminated plates under different application conditions.

Course Contents:

Unit 1

Definition and applications of composite materials: Fibers- glass, carbon, ceramic and aramid fibers; Matrices- polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices. Lamina- assumptions, macroscopic viewpoint, generalized Hooke;s law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness. **(10)**

Unit 2

Manufacturing of composite materials: bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes. **(10)**

Unit 3

Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-

Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates. **(10)**

Unit 4

Analysis of laminated plates: equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies. **(10)**

Recommended/ Reference Books:

1. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.

2. Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill, 1998.

Web Links:

S.N	Address of web source	Content
1.	https://youtu.be/PzdCymgyZ6c	Basics of Composite Materials
2.	https://youtu.be/qloBacY7MRw	Stress and Strain Transformations
3.	https://youtu.be/XRxDpK5-GgY	Quasi- Isotropic Laminates
4.	https://youtu.be/TWyJmrueMew	Governing Equations for Composite Plates
5.	https://youtu.be/2LPapFKRxTI	Thermal Effects in Composite Laminates
6.	https://youtu.be/ko-bxZkxOX0	Buckling of Composite Plates

PEC-RAI-713/21 MODELING, SIMULATION AND OPTIMIZATION (PEC-IV)

B. Tech (Robotics and Artificial Intelligence) VII Semester

No. of Credits: 3				Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total:	100 Marks
				Duration of Exam:	3 Hours

Pre- Requisite: Operation Research

Successive: Nil

Course Objectives:

The objective of this course is to understand the use of design techniques for optimization.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Describe design optimization using simulation.

CO 2- Illustrate different approaches for optimization.

CO 3- Learn different optimization techniques.

CO 4- Apply optimization techniques in mechanical design.

CO5- Describe applications of optimization with respect to functionality; Asthetics, Economics & materials.

Course Contents:

Unit 1

Introduction: Simulation models, purpose of simulation, advantages and disadvantages, simulation issues, Problem formulation: formal problem statement, orientation, project objectives, simulation project manager functions, developing simulation project plan, Gantt chart, introduction to project management softwares, System classification: chart basics, high level flow chart, data to be included in the model, output data and summary. **(5)**

Unit 2

Data collection and analysis: Introduction, data sources and collection, data types, input data distribution, analyzing input data, software usage for data fitting, model translation: simulation program selection, model translation section content, model verification: divide and conquer approach, animation, simulation clock advancing, writing output files, model verification: need and types, face and statistical validity, validation data analysis process **(8)**

Unit 3

Experimental design and analysis: Introduction, factors and levels, N- factors factor experimental designs, 2k experimental designs, refining the experimental alternatives,

terminating and non-terminating system analysis, written report guidelines, presentation guidelines, presentation media, electronic presentation software issues. **(6)**

Unit 4

Training simulators and case studies: Introduction, simulation process planning, modeling, verification and implementation, introduction to ARENA, AutoMod, AutoStat, SIMPAK, case studies **(8)**

Unit 5

Optimization techniques: Introduction to optimization, steps of design optimization, classical methods of optimization, non-conventional design optimization techniques like genetic algorithms, simulated annealing and other techniques. **(6)**

Unit 6

Optimization Techniques Applications: Mechanical system design optimization techniques, optimal selection of materials and processes, human safety and professional ethics, aesthetics and ergonomics in design optimization, advances in design optimization, case studies **(7)**

Recommended/ Reference Books:

1. H. Adeli. Advances in Design Optimization.
2. Simulation modelling handbook: Christopher A. Chung, CRC Press
3. S.S.Rao, Optimization: Theory & Application Wiley Eastern
4. K. Deb, Optimization for Engineering Design, Prentice Hall India
5. J.S.Arora, Introduction to Optimum Design, McGraw Hill

Web Links:

S.N	Address of web source	Content
1.	https://youtu.be/xOf95A5Sk94	Design Prototyping
2.	https://youtu.be/rnVf5mbTNa8	Generic Phases of Design
3.	https://youtu.be/iRbMIt1LBaw	Configurational Design Aspects
4.	https://youtu.be/0tfCRqrcl7s	Concurrent Engineering Approaches
5.	https://youtu.be/hI0NXPKuPnM	Product Development Methodology
6.	https://youtu.be/enDpEQGwtq8	Materials Selection In Engineering Design- I
7.	https://youtu.be/1xBWM0OhGh4	Materials Selection In Engineering Design- II
8.	https://youtu.be/NppPm4efsA8	Basic Steps in the Material Selection Process

PEC-RAI-714/21 MICRO AND NANO MANUFACTURING (PEC-IV)

B. Tech (Robotics and Artificial Intelligence) VII Semester

No. of Credits: 3		Sessional:	25 Marks
L T P Total		Theory:	75 Marks
3 0 0 3		Total :	100 Marks
		Duration of Exam:	3 Hours

Pre- Requisite: Material Science, Physics

Successive: None

Course Objectives:

The objective of this course is to familiarize the students with the processes and techniques of micro and nano manufacturing.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Understand the synthesis and processing at micro and nano scale.

CO 2- Describe the micro-manufacturing techniques and related instrumentation.

CO 3 Discuss the nanofabrication techniques and nanomaterials.

CO 4 Distinguish between various non-conventional micro-nano manufacturing processes.

CO 5- Classify methods for surface and structural characterization of materials.

Course Contents:

Unit 1

Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology.

Nano materials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nanomaterials- solgel process, Liquid solid reactions; Gas Phase synthesis of nanomaterials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing(GPC), Chemical Vapour Condensation(CVC)- Cold Plasma Methods, Laser ablation, Vapour – liquid –solid growth, particle precipitation aided CVD, summary of Gas Condensation Processing (GPC). **(7)**

Unit 2

Micro-manufacturing Techniques: Introduction to micromachining, Micro drilling – process, tools and applications Micro turning- process, tools and applications, Diamond Micro turning – process, tools and applications Micro milling and Micro grinding – process,

tools and applications Micro extrusion- process and applications Nano- Plastic forming, Laser technology in micro manufacturing- Practical Lasers, application of technology fundamentals, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining. Micro instrumentation – applications. **(7)**

Unit 3

Nanofabrication Techniques: Introduction to Nanofabrication, Nanofabrication using soft lithography – principle, applications – Examples (Field Effect Transistor, Elastic Stamp) Introduction to Carbon nano-materials – CN Tubes CN Tubes – properties and applications CN Tube Transistors – Description only CVD Diamond Technology, LIGA Process, Nano-finishing operations. **(6)**

Unit 4

Introduction to Non-conventional micro-nano manufacturing Processes: principle and applications – Abrasive Jet Micro Machining, WAJMM Micro EDM, Micro WEDM, Micro EBM – Process principle, description and applications Micro ECM, Micro LBM - Process principle, description and applications Focused ion beams - Principle and applications. **(7)**

Unit 5

Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).

Spectroscopic characterizations: Basic concepts of spectroscopy, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurement, Raman spectroscopy. **(8)**

Unit 6

Surface Characterization: X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS).

Thermal Characterization of Nanomaterials: DTA, TGA, DSC (Principle and Applications), Determination of thermo-physical parameters. **(5)**

Recommended/Reference Books:

1. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press.

2. Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore, Introduction to Nanoscience and Nanotechnology, CRC Press.
3. V.K.Jain, Micro-manufacturing Processes, CRC Press,
4. Ray F. Egerton , Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM , Springer.
5. Robert F Speyer, Thermal Analysis of Materials, Marcel Dekker Inc, New York.
6. B.D. Cullity - Elements of X-Ray Diffraction, 3rd edition, Prentice Hall.

PEC-RAI-715/21INTRODUCTION TO NC, CNC PROGRAMMING (PEC-IV)

B. Tech (Robotics and Artificial Intelligence) VII Semester

No. of Credits: 3		Sessional:	25 Marks
L T P Total		Theory:	75 Marks
3 0 0 3		Total :	100 Marks
		Duration of Exam:	3 Hours

Course Objectives:

The objective of studying this course is to acquaint the students about the numerical control systems and to develop related programming skills.

Course Outcomes (COs): At the end of the course, the student shall be able to:

- **CO 1-** Understand the fundamental concepts of numerical control.
- **CO 2-** Prepare punched tape
- **CO 3-** Prepare part program for lathe, drilling and milling machines.
- **CO 4-** Understand the basics of CNC and DNC systems.
- **CO 5-** Understand the basics of adaptive control systems.
- **CO 6-** Describe basic physical configurations and features of robots.

Course Contents:

Unit 1

Numerical Control: Introduction to numerical control, NC components, NC coordinate systems, Point to point, lined and contouring systems, open and close loop control system, Steps in NC manufacturing, Advantages and disadvantages of NC machines, Role of NC/CNC technology in modern manufacturing, Features of CNC machining centre and CNC turning centre, Tooling for CNC systems, Automatic tool changer, Actuation systems, Feedback devices: Encoders and linear scale. **(8)**

Unit 2

Input media: Types of input media, punched tape, Program tape composition and coding format. **(5)**

Unit 3

Part programming: Introduction, part program composition, Preparatory codes, Miscellaneous codes, Cutter diameter and length compensation, Part programming for lathe, drilling and milling machines, Computer assisted part programming, Computer assisted part programming languages, CAD/CAM approach of programming. **(9)**

Unit 4

CNC and DNC: Computer numerical control: Problems with conventional NC, Introduction to computer numerical control, Functions of CNC, Features of CNC, Difference between NC and CNC, Advantages, Disadvantages and Applications of CNC; Direct numerical control: Introduction, Components of DNC system, Types of DNC, Functions of DNC, Advantages of DNC; Difference between direct and distributed numerical control. **(6)**

Unit 5

Adaptive control: Introduction, Sources of variability in machining, Types of adaptive control, Operation of an ACC system, where to use adaptive control, Benefits of adaptive control machining. **(4)**

Unit 6

Robotics: Introduction, Joints and links used in robots, Robot physical configurations, Joint drive systems, Robot control systems, End effectors, Sensors in robotics, Robot motion systems, technical features of robot-like work volume, precision of movement, speed of movement, weight carrying capacity, Programming methods of robot, Intelligent robots, Vision systems, Applications of Industrial robots. **(6)**

Reference Books:

1. CNC Technology and Programming- Tilak Raj, Dhanpat Rai Publishing Company, New Delhi

2. CAD/CAM: computer-aided design and manufacturing - M. P. Groover, E. W. Zimmers, Prentice-Hall

3. Computer Aided Manufacturing - T. K. Kundra, Tata McGraw-Hill Education

4. Computer Control of Manufacturing Systems - Y. Koren, Tata McGraw-Hill Education

5. Automation, Production systems, and Computer-Integrated Manufacturing - M. P. Groover, Pearson Education

Web Links

S. No	Address of web source	Content
1	https://youtu.be/-yJMC6sbbbE	Computer numerical control
2	https://youtu.be/YoJHy-OR7J0	CNC machining
3	https://youtu.be/3skaybdK--Q	CNC tooling
4.	https://youtu.be/U4Wc7pNCXXA	CNC part programming
5.	https://youtu.be/1ER8HkhAcFQ	Robotics

PEC-RAI-721/21 PROCESS PLANNING AND COST ESTIMATION (PEC-V)
B. Tech (Robotics and Artificial Intelligence) VII Semester

No. of Credits: 3		Sessional:	25 Marks
L T P	Total	Theory:	75 Marks
3 0 0	3	Total :	100 Marks
		Duration of Exam:	3 Hours

Course Objectives:

The objective of this course is to introduce process planning concepts to make cost estimation for various products .At the end of course, the students will be able to:

Course Outcome (COs): At the end of the course, the student shall be able to:

CO1- Understand the basic concepts of process planning.

CO2- Gain knowledge about the various activities involved in process planning.

CO3- Evaluate about the cost estimation and its procedure

CO4- Understand the machining time of different machines

Course Contents:

Unit 1

Introduction of Process Planning- methods of process planning, , material evaluation, steps in process selection, production equipment and tooling selection. **(8)**

Unit 2

Process planning activities- process parameter calculation for various production processes, selection of jigs and fixtures, selection of quality assurance methods, documents for process planning. **(8)**

Unit 3

Introduction to cost estimation importance of costing and estimation, methods of costing, elements of cost estimation, types of estimates. **(7)**

Unit 4

Estimating procedure, estimation of labor cost, material cost, allocation of overhead charges, calculation of depreciation cost, cost of conversion. **(10)**

Unit 5

Calculation of machining time for different machines such as lathe, drilling, Milling, shaping
, grinding. **(8)**

Unit 6

Estimation of forging cost, estimation of welding cost, estimation of foundry cost, estimation of machining cost. **(8)**

Recommended/ Reference Books:

1. Process Planning, Design/ Manufacture Interface, by Peter Scalon, Elsevier publication,

2. Manufacturing Processes and Systems, by Ostwaal , John Wiley , Publication

3. Product Design and Manufacturing, by R.C Gupta, Prentice Hall Publication

Website link

S.N	Website link	Content covered
1	https://easyengineering.net/process-planning-and-cost-estimation-by-jayakumar/	UNIT 1,2,3
2	"https://www.youtube.com/embed/ddvMPpJnwTM"	Unit 4
3	"https://www.youtube.com/embed/xLFSKrDcZ40"	Unit 5,6

PEC-RAI-722/21 NON-CONVENTIONAL ENERGY RESOURCES UTILIZATION (PEC-V)

B. Tech (Robotics and Artificial Intelligence) VII Semester

No. of Credits: 3

L T P Total
3 0 0 3

Sessional: 25 Marks
Theory : 75 Marks
Total : 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Thermodynamics

Successive: Nil

Course Objectives:

The objective of this course is to study energy resources, energy planning and their utilization.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Understand the energy resources and its requirement.

CO 2- Understand production and utility of bio-gas and solar energy.

CO 3- Describe concept and application of wind energy.

CO 4- Understand tidal energy as alternate resource.

CO 5- Discuss the utility of thermoelectric Systems.

Course Contents:

Unit 1

Energy Resources and their Utilization : Indian and global energy sources, Energy exploited, Energy planning including Indian Energy Policy, Energy parameters (energy intensity, energy-GDP elasticity), Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, Decentralized and dispersed generation. Economics. Impact of renewable energy generation on environment, Kyoto Protocol, Cost of electricity production from different energy sources, Energy options for Indian economy. **(6)**

Unit 2

Solar Radiations: Extra terrestrial radiation, Spectral distribution, Solar constant, Solar radiations on earth, Measurement of solar radiations, Solar radiation geometry, Flux on a

plane surface, Latitude, Declination angle, Surface azimuth angle, Hour angle, Zenith angle, Solar altitude angle expression for angle between incident beam and the normal to a plane surface (no derivation), Local apparent time, Apparent motion of sun, Day length, Solar radiation data for India.

Solar Energy: Solar thermal power and it's conversion, Solar collectors, Flat plate, Performance analysis of flat plate collector, Solar concentrating collectors, Types of concentrating collectors, Thermodynamic limits to concentration, Cylindrical collectors, Thermal analysis of solar collectors, Tracking CPC and solar swing. Solar thermal energy storage, Different systems, Solar pond. Applications, Water heating, Space heating & cooling, Solar distillation, Solar pumping, Solar cooking, Greenhouses, Solar power plants.
Solar photovoltaic system: Photovoltaic effect, Efficiency of solar cells, Semiconductor materials for solar cells, Solar photovoltaic system, Standards of solar photovoltaic system, Applications of PV system, PV hybrid system, Batteries for Solar System. **(06)**

Unit 3

Biogas: Photosynthesis, Bio gas production, Aerobic and anaerobic bio-conversion process, Raw materials, Properties of bio gas, Producer gas, Transportation of bio gas, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production, Bio gas applications, Biomass conversion techniques, Biomass gasification, Energy recovery from urban waste, Power generation from liquid waste, Biomass cogeneration, Energy plantation, Fuel properties, Biomass resource development in India. **(06)**

Unit 4

Wind Energy*:* Properties of wind, Availability of wind energy in India, wind velocity, Wind machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Wind energy farms, Economic issues, Recent development.**(06)**

Unit 5

Tidal Power: Tides and waves as sources of energy, Fundamentals of tidal power, Use of tidal energy, Limitations of tidal energy conversion systems.
Ocean Energy: Principle of ocean thermal energy conversion, Wave energy conversion

machines, Power plants based on ocean energy, Problems associated with ocean thermal energy conversion systems, Thermoelectric OTEC, Developments of OTEC. **(06)**

Unit 6

Thermoelectric Systems: Properties of thermoelectric materials, Fusion Plasma generators. Geothermal energy: Structure of earth's interior, Geothermal sites, earthquakes &volcanoes, Geothermal resources, Hot springs, Steam ejection, Principal of working, Types of geothermal station with schematic representation, Site selection for geothermal power plants. Advanced concepts, Problems associated with geothermal conversion. **(06)**

Recommended/ Reference Books:

1. Bansal Keemann, Meliss," Renewable energy sources and conversion technology", Tata McGraw Hill.

2. Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd.

3. Ashok V. Desai, "Non conventional Energy", New Age International Publishers Ltd.

Web link	contents
https://nptel.ac.in/courses/121/106/121106014/	**Solar Energy:**
https://nptel.ac.in/courses/121/106/121106014/	**Bio Mass**
https://nptel.ac.in/courses/121/106/121106014/	**Ocean Energy**
https://nptel.ac.in/courses/121/106/121106014/	**Wind Energy**

PEC-RAI-723/21 MANUFACTURING PROCESSES (PEC-V)

B. Tech (Robotics and Artificial Intelligence) VII Semester

No. of Credits: 3
LT P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Nil

Successive: Nil

Course Objectives:

The objective of studying this course is to get an insight of the various processes which change the shape, size and form of the raw materials into the desirable products by conventional methods.

Course Outcome (COs): At the end of the course, the student shall be able to:

CO1- Describe different metal casting processes.

CO2- Analyze the plastic deformation of metals in metal forming.

CO3- Describe different machine tools.

CO4- Acquire knowledge about basic welding processes and their selection for fabrication of different components.

CO5- Understand the basics principles of advance manufacturing processes and their applications.

Course Contents:

Unit 1

Metal Casting Processes: Introduction, Advantages, limitations and applications; Sand mould making procedure; Patterns: Pattern materials, types of patterns, pattern allowances, Moulding: Mould materials, properties of moulding sand, main constituents of moulding sand, classification of moulding sand, preparation of moulding sand, testing of moulding sand, methods of moulding; Gating System: Requirements of a gating system, elements of gating system, chills; Cores: essential characteristics of good core, types of cores, core making, core print, core chaplets, Special casting processes: Permanent mould casting, Die casting, Centrifugal casting, Shell moulding, Precision investment casting, Continuous casting; Casting defects and their remedies. **(10)**

Unit 2

Metal Forming: Nature of plastic deformation, Hot working and cold working, Rolling: Principle, Rolling stand arrangement, Forging: Forging operations, Smith Forging, Drop forging, Press forging and Machine forging, Extrusion: principle, Hot extrusion processes, cold extrusion processes, Wire drawing **(6)**

Unit 3

Machine Tools: Introduction; Lathe: principal parts, size and specifications, lathe accessories, lathe operations; Shaper: principal parts, working principle, specifications of a shaper; Drilling machine: principal parts, working principle, size and specifications, drilling operations, Milling machine: principal parts, milling operations. **(6)**

Unit 4

Welding and Allied Processes: Introduction, Classification of welding processes, Gas Welding: Principle, types of flames, equipment's; Resistance Welding: Principle and types-spot welding, seam welding, projection welding; Arc Welding: principle, equipment's, Arc welding processes: Metal arc welding, Carbon arc welding, TIG, MIG, Submerged arc welding; Brazing and Soldering; Welding defects and their remedies**. (6)**

Unit 5

Advance Manufacturing Processes: Electric Discharge Machining: Introduction, Principle, Dielectric Fluid, Electrodes, Process Characteristics, applications; Electro Chemical Machining: Principle of ECM, ECM Equipment, Electrolyte, Process Characteristics, Applications; Ultrasonic Machining, Laser Beam Machining, Abrasive Water Jet Machining: Principle, Equipment, Process Parameters, Applications; Electron Beam Machining. **(10)**

Reference Books:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition) Pearson India.

2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems

3. Degarmo, Black & Kohser, Materials and Processes in Manufacturing.

4. Amitabh Ghosh and Asok Kumar Mallik, Manufacturing Science, Affiliated East-West Press Private Limited.

Web Links

S. No	Address of web source	Content
1	https://youtu.be/-Gh24aiFFVw	Introduction to casting
2	https://youtu.be/cW7Ocs1VKh8	Pattern and moulds
3	https://youtu.be/xn95DsahWIo	Sand mould and gating system
4.	https://youtu.be/m6ifYE4k-gQ	Various welding processes
5.	https://youtu.be/wNg86XwzBhE	Gas welding, brazing and soldering, welding defects
6	https://youtu.be/dNbVsmVgOnM	Metal working processes: hot working and cold working

PEC-RAI-724/21 FINITE ELEMENT ANALYSIS (PEC- V)
B. Tech (Robotics and Artificial Intelligence) VII Semester

No. of Credits: 3		Sessional:	25 Marks
L T P	Total	Theory:	75 Marks
3 0 0	3	Total :	100 Marks
		Duration of Exam:	3 Hours

Course Objectives:

The objective of this course is to introduce the concepts of Mathematical Modeling of Engineering Problems and to appreciate the use of FEM to a range of Engineering Problems.

Course Outcomes (COs): After completing this course, the students will be able to:

CO 1- Understand Different mathematical Techniques used in FEM analysis use of them in Structural and thermal problems.

CO2- Analyze one dimensional problems in FEM.

CO3- Formulate and solve two dimensional scalar and vector variable problems.

CO4- Formulate Isoparametric problems.

Course Contents:

Unit 1

Introduction: Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

Unit 2

One-Dimensional Problems: One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.

Unit 3

Two Dimensional Scalar Variable Problems: Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

Unit 4

Two Dimensional Vector Variable Problems: Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations

- Plate and shell elements.

Unit 5

Isoparametric Formulation: Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Recommended/Reference Books:

1. Reddy. J.N., "An Introduction to the Finite Element Method", Tata McGrawHill,
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, www.padeepz.net www.padeepz.net
3. Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann
4. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd.,
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis, Wiley Student Edition.
6. Chandrupatla&Belagundu, "Introduction to Finite Elements in Engineering, Edition, Prentice Hall College Div.
7. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons,

PEC-RAI-725/21 NEW VENTURE CREATION (PEC-V)

B. Tech. (Robotics and Artificial Intelligence) VII Semester

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Industrial Engineering

Successive: Product Design and Development

Course Objectives:

The aim of this course is to provide know-how for being able to launch a new venture by identifying the entrepreneurial opportunities, support and resource requirements.

Course Outcomes: At the end of the course, the student shall be able to:

CO 1-Acquire knowledge about entrepreneur and entrepreneurship.

CO 2- Understand the various activities involved in establishment of small scale enterprises.

CO 3-Identify the operational issues of small scale enterprises.

CO 4-Understand the performance appraisal methods and growth strategies.

CO 5-Comprehend the life cycle approach of production management.

Course Contents:

Unit 1

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises. **(6)**

Unit 2

Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site. **(8)**

Unit 3

Planning a Small Scale Enterprises: Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership, Preparation of project report. **(8)**

Unit 4

Operational Issues in SSE: Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws. **(8)**

Unit 5

Performance appraisal and growth strategies: Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth. **(6)**

Unit 6

Life cycle of production management: Stages in life cycle of production management and Major managerial Decisions involved in each stage. **(4)**

Recommended/ Reference Books:

1. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 6th ed., Pearson Edu., 2019.

2. D.F. Kuratko and T.V. Rao, Entrepreneurship: A South-Asian Perspective, Cengage Learning, 2013.

3. Dr. S.S. Khanka, Entrepreneurial Development (4th ed.), S Chand & Company Ltd., 2012.

4. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.

Web Links:

S.N	Address of web source	Content
1.	https://nptel.ac.in/courses/110/106/110106141/	Unit 1 to 5
2.	https://nptel.ac.in/courses/127/105/127105007/	Unit 1 to 5

OPEN ELECTIVES COURSES
OFFERED BY
OTHER DEPARTMENTS

COURSES OFFERED BY COMPUTER ENGINEERING AND INFORMATION TECHNOLOGY DEPARTMENT

(OPEN ELECTIVE COURSES-1) (OEC-1)

OEC-RAI-502 CYBER LAWS AND SECURITY

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total : 100 Marks
Duration of Exam: 3 Hours

Course Objectives:
To understand the principles of Cyber Laws and
Security and application to the functioning of an Organization

Course Outcomes (COs); At the end of the course, the student shall be able to:

CO1 To understand of Principle of Information Systems
CO2 Understanding of Knowledge Security Threats
CO 3 Familiarisation of Model of Cryptographic Systems
CO 4 To know Security metrics

Course Contents:

Unit 1:

History of Information Systems and its Importance, basics, Changing Nature of Information Systems, Need of Distributed Information Systems, Role of Internet and Web Services, Information System Threats and attacks, Classification of Threats and Assessing Damages Security in Mobile and Wireless Computing- Security Challenges in Mobile Devices, authentication Service Security, Security Implication for organizations, Laptops Security Basic Principles of Information Security, Confidentiality, Integrity Availability and other terms in Information Security, Information Classification and their Roles.

Unit 2:

Security Threats to E Commerce, Virtual Organization, Business Transactions on Web, E Governance and EDI, Concepts in Electronics payment systems, E Cash, Credit/Debit Cards. Physical Security- Needs, Disaster and Controls, Basic Tenets of Physical Security and Physical Entry Controls, Access Control- Biometrics, Factors in Biometrics Systems,

Benefits, Criteria for selection of biometrics, Design Issues in Biometric Systems, Interoperability Issues, Economic and Social Aspects, Legal Challenges.

Unit 3:

Model of Cryptographic Systems, Issues in Documents Security, System of Keys, Public Key Cryptography, Digital Signature, Requirement of Digital Signature System, Finger Prints, Firewalls, Design and Implementation Issues, Policies Network Security- Basic Concepts, Dimensions, Perimeter for Network Protection, Network Attacks, Need of Intrusion Monitoring and Detection, Intrusion Detection Virtual Private Networks- Need, Use of Tunneling with VPN, Authentication Mechanisms, Types of VPNs and their Usage, Security Concerns in VPN.

Unit 4:

Security metrics- Classification and their benefits Information Security & Law, IPR, Patent Law, Copyright Law, Legal Issues in Data mIning Security, Building Security into Software Life Cycle Ethics- Ethical Issues, Issues in Data and Software Privacy Cyber Crime Types & overview of Cyber Crimes.

Text Books/ Reference Books:

1. Godbole,“ Information Systems Security”, Willey
2. Merkov, Breithaupt, “ Information Security”, Pearson Education
3. Yadav, “Foundations of Information Technology”, New Age, Delhi
4. Schou, Shoemaker, “ Information Assurance for the Enterprise”, Tata McGraw Hill
5. Sood,“Cyber Laws Simplified”, Mc Graw Hill
6. Furnell, “Computer Insecurity”, Springer 7. IT Act 2000

OEC-RAI-504 WEB TECHNOLOGY AND INFORMATION RETRIEVAL

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Objectives:

1. To get knowledge of Web Server Technology and Web search concepts.
2. To understand the basics of web crawlers and types of crawlers.
3. To identify Information retrieval problem and the different types of indices: inverted index, positional index, bi-word index etc.
4. To understand various techniques of index construction.

Course Outcomes: At the end of the course, the student shall be able to:

1. Understand Web Server Technology and Web Search Basics
2. Familiar with Web Crawlers
3. Know Information Retrieval
4. Understand Index Construction

Course Contents:

Unit 1:

Web Server Technology: Web's Robot global access to information, HTML, HTTP, Accessing a web server, publishing on web server, secure HTTP, Secure Sockets Layer, WWW Proxies, IIS, Case study of Apache web server.

Unit 2:

Web Search Basics: Background and history, Anatomy of WWW, Web characteristics, Spam, The web graph, The Web Search Users, search engines, architecture of search engines, search tools, DNS resolution, The URL frontier, Link analysis, Page Rank.

Unit 3:

Web Crawlers: Basics of Web crawling, Various crawling techniques, incremental crawler, parallel crawler, distributed crawlers, focused crawler, agent-based crawler, Hidden web Crawler.

Unit 4:

Introduction to Information Retrieval: Information retrieval problem, an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval, an inverted index, Bi-word indexes, Positional indexes, Combination schemes

Unit 5:

Index Construction: Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing, other types of indexes Index compression: Statistical properties of terms in information retrieval, Heaps' law: Estimating the number of terms, Zipf's law: Modelling the distribution of terms, Dictionary compression, Dictionary as a string, Blocked storage, Postings file compression.

REFERENCES

1. C. D. Manning, P. Raghavan and H. Schütze, Introduction to Information Retrieval, Cambridge University Press, 2008 (available at http://nlp.stanford.edu/IR-book).

2. Chakrabarti, S. (2002). Mining the web: Mining the Web: Discovering knowledge from hypertext data. Morgan-kaufman.

3. B. Croft, D. Metzler, T. Strohman, Search Engines: Information Retrieval in Practice, Addison- Wesley, 2009 (available at http://ciir.cs.umass.edu/irbook/).

4. R. Baeza-Yates, B. Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley,2011 (2nd Edition).

5. An Introduction to Information Retrieval Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze Cambridge University Press.

OEC-RAI-505 INTELLECTUAL PROPERTY RIGHTS

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Objectives:

To understand the principles of intellectual property rights.

Course Outcomes (COs) : At the end of the course, the student shall be able to:

CO1 Explore Principle of Intellectual Property
CO2 Expedite Introduction to Patents
CO3 Familiarise of Compulsory License
CO4 Know Infringement.

Course Contents:

Unit 1:

Introduction to Intellectual Property: Concept of Intellectual Property, Kinds of Intellectual Property, Economic Importance of Intellectual Property, **Indian Theory on Private Property:** Constitutional Aspects of Property, Constitutional Protection of Property and Intellectual Property, **Economic Development and Intellectual Property Rights Protection**

Unit 2:

Introduction to Patents: Overview, Historical Development, Concepts: Novelty, Utility, **Patentable Subject-matter:** Patent Act, 1970- Amendments of 1999, 2000, 2002 and 2005, Pharmaceutical Products and Process and Patent , Protection, Software Patents, Business Method, Protection of Plant Varieties and Farmers' Rights Act, 2001, Patenting of Micro-organism

Unit 3:

Procedure of Obtaining of Patents: Concepts of a Patent Application,, Specification: Provisional, Complete, Disclosure Aspects, Claims: Principal, Dependant, Omnibus, Examination of Application, Opposition of Application, Sealing of Patents

Unit 4:

Working of Patents – Compulsory License: Commercialization of Inventions: License-Terms of License Agreement, Assignments of Patents, Revocation of Patents

Unit 5:

Infringement: What is Infringement?, How is Infringement determined? Who is an Infringer? Direct, Contributory and Induced, Defences of Infringement: 5.2.1 Research Exemption, Invalidity, Misuse, Failure to mark, Laches and Estoppel and first sale doctrine

Text Books/ Reference Books:

1. W.R. Cornish, Intellectual Property, Sweet & Maxwell, London (2000)
2. P. Narayana, Patent Law, Wadhwa Publication
3. Merges, Patent Law and Policy: Cases and Materials, 1996
4. Brian C. Reid, A Practical Guide to Patent Law, 2nd Edition, 1993
5. Brinkhof (Edited), Patent Cases, Wolters Kluwer.
6. Prof. Willem Hoyng& Frank Eijsvogels, Global Patent Litigation, Strategy and Practice, Wolters Kluwer.
7. Gregory Stobbs, Software Patents Worldwide, Wolters Kluwer.
8. Feroz Ali Khader, The Law of Patents- With a special focus on Pharmaceuticals in India, Lexis Nexis Butterworths Wadhwa, Nagpur.
9. Sookman, Computer Law, 1996
10. N.S. Gopalakrishnan& T.G. Agitha, Principles of Intellectual Property (2009). Eastern Book Company, Lucknow.

COURSES OFFERED BY CIVIL ENGINEERING DEPARTMENT (OPEN ELECTIVE COURSES-1) (OEC-1)

OEC-RAI-506 BASIC ENVIRONMENTAL ENGINEERING

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Objectives: This course is designed to enable a better understanding of human impact on our surroundings and the environmental needs of the future.

Course Outcomes (COs): After completing this course the students will be able to:

CO1- Study a variety of topics that include: biotic and abiotic factors in habitats; ecosystems and biomes;

CO2 – Understand interrelationships among resources and an environmental system;

CO3 – Understand sources and flow of energy through an environmental system;

CO4 – Establish relationships between carrying capacity and changes in populations and ecosystems.

Course Contents:

UNIT 1: Water: -Sources of Water and quality issues, water quality requirement for different beneficial uses, Water quality standards, water quality indices, water safety plans, Water Supply systems, Need for planned water supply schemes, Water demand industrial and agricultural water requirements, Components of water supply system; Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design. Water Treatment: aeration, sedimentation, coagulation flocculation, filtration, disinfection, advanced treatments like adsorption, ion exchange, membrane processes

UNIT 2: Sewage- Domestic and Storm water, Quantity of Sewage, Sewage flow variations. Conveyance of sewage- Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems. Small bore systems, Storm Water- Quantification and design of Storm water; Sewage and Sullage, Pollution due to improper disposal of sewage, National River cleaning plans, Wastewater treatment, aerobic and anaerobic

treatment systems, suspended and attached growth systems, recycling of sewage – quality requirements for various purposes.

UNIT 3: Air - Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution automobile pollution, Chemistry of combustion, Automobile engines, quality of fuel, operating conditions and interrelationship. Air quality standards, Control measures for Air pollution, construction and limitations

UNIT 4: Noise- Basic concept, measurement and various control methods.

UNIT 5: Solid waste management-Municipal solid waste, Composition and various chemical and physical parameters of MSW, MSW management: Collection, transport, treatment and disposal of MSW. Special MSW: waste from commercial establishments and other urban areas, solid waste from construction activities, biomedical wastes, Effects of solid waste on environment: effects on air, soil, water surface and ground health hazards. Disposal of solid waste-segregation, reduction at source, recovery and recycle. Disposal methodsIntegrated solid waste management. Hazardous waste: Types and nature of hazardous waste as per the HW Schedules of regulating authorities.

UNIT 6: Building Plumbing-Introduction to various types of home plumbing systems for water supply and waste water disposal, high rise building plumbing, Pressure reducing valves, Break pressure tanks, Storage tanks, Building drainage for high rise buildings, various kinds of fixtures and fittings used.

Text/Reference Books:

1. Introduction to Environmental Engineering and Science by Gilbert Masters, Prentice Hall, New Jersey.

2. Introduction to Environmental Engineering by P. Aarne Vesilind, Susan M. Morgan, Thompson /Brooks/Cole; Second Edition 2008.

3. Peavy, H.s, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw - Hill International Editions, New York 1985.

4. MetCalf and Eddy. Wastewater Engineering, Treatment, Disposal and Reuse, Tata McGraw-Hill, New Delhi.

5. Manual on Water Supply and Treatment. Ministry of Urban Development, New Delhi.

6. Plumbing Engineering. Theory, Design and Practice, S.M. Patil, 1999

7. Integrated Solid Waste Management, Tchobanoglous, Theissen & Vigil. McGraw Hill Publication

8. Manual on Sewerage and Sewage Treatment Systems, Part A, B and C. Central Public Health and Environmental Engineering Organization, Ministry of Urban Development.

OEC-RAI- 507 TRAFFIC ENGINEERING AND MANAGEMENT

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Outline: Traffic engineering and management is a first level post graduate course in Transportation Systems Engineering. The course introduces the concepts of characterizing traffic, various modeling approaches, and design of facilities to control and manage traffic. The course is designed in a modular fashion so that each module will introduce the underlying principles, current practice, ample numerical illustrations, and few case studies of broad areas of the subject. The modules are sequenced in such a way that the course first introduces simple, but fundamental characteristics of traffic and move gradually to complex traffic management concepts. The last module is devoted for advanced and specialized traffic facilities. Although the major focus of the course is urban vehicular traffic, some effort is taken to show how these lessons can be applied to other modes as well. A key feature of the course is that it is well knit with the current design and analysis practice stipulated in both national and international codes, standards, and manuals.

Course Contents:

Unit 1:

Contents: Traffic stream characteristics; Traffic measurement procedures; Microscopic traffic flow modeling; Macroscopic and mesoscopic traffic flow modeling; Uninterrupted flow; Traffic intersection control; and Traffic impact studies.

Unit 2:

Traffic stream characteristics: Introduction to traffic engineering: Road user characteristics, human and vehicle characteristics; Fundamental parameters and relations of traffic flow: speed, density, volume, travel time, headway, spacing, time-space diagram, time mean speed, space mean speed and their relation,relation between speeds, flow, density, fundamental diagrams; Traffic stream models: Greenshield's model, Greenberg's logarithmic model, Underwood's exponential model, pipe's generalized model, multi-regime models; Moving observer method: Concepts and derivation, illustration, Calibration of Greenshild's model.

Unit 3:

Traffic measurement procedures: Measurement at a point: Traffic volume measurement, equipment for flow measurements, data analysis, concepts ofADT,AADT; Measurement over a short section:Speed measurements, 15th and 85th percentile speeds, design speed, speed distributions; Measurement along a length of road: Density measurement, travel time measurement; Automated traffic measurement: GPS devices, loop detectors, video analysis, and other technologies.

Unit 4:

Microscopic traffic flow modelling: Car-following models: Concept of stimulus-response, general mottoes models, safety distance, pscho-physical, optimal velocity, fuzzy logic models, and applications; Lane changing models: Conceptual framework, lane selection model, gap acceptance models;model, gap acceptance models; Vehicle arrival models: Poisson distribution, headway modeling, random vehicle generation; Microscopic traffic simulation:Vehicle generation, design, calibration, validation, applications, operational models

Unit 5:

Macroscopic and mesoscopic traffic flow modelling: Traffic flow modeling analogies: Fluid flow analogy, heat flow analogy, granular flow, Lighthill-Withams theory, shock waves; Cell transmission models: Flow conservation, flow transmission; Traffic progression models: Robertson progression model, platoon movement, dispersion index, applications; Discrete simulation models: Cellular automata concepts, discretization of time and space,rules for acceleration, deceleration, randomization, and vehicle updation.

Unit 6:

Uninterrupted flow: Capacity and Level of service LOS: Definitions, highway capacity, factors affecting LOS, HCM methods; Urban Street: Classification, operational performance measures, congestion management; Multilane highways: Characteristics, capacity and level of service; Freeway operations: Operational considerations, capacity and level of service of a basic freeway segment, weaving operation; Ramp metering: Merging and diverging areas; gap acceptance, speed at ramps; fixed, reactive, and predictive systems; Corridor analysis:

Text Books/ Reference Books:

1. Roess, RP., McShane, WR. and Prassas,ES.(1998), Traffic Engineering,Prentice Hall.

2. May,A. D.(1990), Fundamentals of Traffic Flow,Prentice Hall.
3. Papacostas, C.S.(1987), Fundamentals of Transportation Engineering,Prentice Hall.
4. Kadiyali, LR (1987), Traffic Engineering and Transportation Planning,Khanna.
5. Highway Capacity Manual (2000), Transportation Research Board, USA.
6. Khanna,S.K. and Justo, C.E. G.(1991), Highway Engineering, Nemchand.

OEC-RAI-508 CONTRACTS MANAGEMENT

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Objectives: At the end of the course, the student shall be able to:

CO1 Understand the various types of contracts

CO2 Understand the use and effect of contracts in construction industry

Course Contents:

Unit 1:

Introduction to contracts: Definitions, Essentials for a legally valid contract, Salient features of contract, Discharging of a contract, Documents for an Engineering Contract; Types of contracts: Classification Based on − Tendering Process, Economic Consideration, Applicability of the various types of contracts in Construction.

Unit 2:

Tendering process: Definitions, List of Documents, EMD, Security Deposit, Invitation for Tenders and sale of Documents, Preparation of Tender Documents and its submission, Receipt of Tender Documents and its opening, Evaluation of Tender and Award of contract – Letter of Award, Letter of Intent, Issues in tendering process: Pre - Registration, Pre – Qualification, Nominated Tendering, Rejection of Tenders, Repeat Orders, Revocation of Tenders, Unbalanced Bidding

Unit 3:

Administration/Performance of contract: Responsibilities (Duties and Liabilities) of Principal & Contractor, Monitoring and Quality control/assurance, Settlement of claims − Advances, Bills, Extension for time, Extras & Variations, Cost Escalations. Security Deposit, Retention Money, Performance Bond, Liquidated Damages, Penalties, Statutory Requirements.

Unit 4:

Breach of contract: Definition and Classification, Common Breaches by – Principal, Contractor, Damage Assessment, Claims for Damages.

Unit 5:

Dispute resolution: General, Methods for dispute resolution − Negotiations, Mediation, Conciliation, Dispute Resolution Boards, Arbitration, Litigation/Adjudication by courts. Conciliation − Appointment of Conciliator, Role of Conciliator, Special Features of Conciliation Dispute Resolution Boards (DRB) − Constitution Of DRB, Functioning of DRB, Procedure for Hearings, Status of Award.

Text Books/ Reference Books:

1. Vaid K.N., (1998)"Global perspective on International Construction Contracting Technology and Project Management", NICMAR, Mumbai
2. Prakash V. A.,(1997) “Contracts Management in Civil Engineering Projects”, NICMAR
3. Patil B. S.,(2009) “Civil Engineering Contracts and Estimates”, University Press.
4. John G. Betty(1993/ Latest Edition) “Engineering Contracts”, McGraw Hills.
5. Vasavada B. J.,(1997), “Engineering Contracts and Arbitration”, (Self Publication by JyotiB.Vasavada).
6. Albett Robert W., (1961/ Latest Edition) "Engineering Contracts and Specifications”, John. Willey and Sons, New York.

OEC-RAI-509 SOLID AND HAZARDOUS WASTE MANAGEMENT

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Objective:

This course provides an in depth understanding of solid and hazardous waste characteristics and management. Some basics of radioactive waste characterization and handling are also provided.

Course Outcomes (COs): After completing this course, the students will be able to:

CO1- Learn comprehensive overview of solid, biomedical and hazardous wastemanagement.

CO2 - Have knowledge on solid waste management designaspects.

CO3 - Learn about the different methods of solid wastemanagement.

Course Contents:

UNIT 1: Contents: Solid Waste analysis and characterization, Hazardous waste Characterization Environmental legislation for solid and hazardous waste disposal and transport Risk Assessment, Waste minimization and resource recovery, Waste stabilization techniques, Chemical, physical and biological treatment Landfill design for Sanitary and Hazardous Wastes, Incineration.

UNIT 2: Relevant Regulations Municipal solid waste (management and handling) rules; hazardous waste (management and handling) rules; biomedical waste handling rules; fly ash rules; recycled plastics usage rules; batteries (management and handling) rules

UNIT 3: Municipal Solid Waste Management – Fundamentals Sources; composition; generation rates; collection of waste; separation, transfer and transport of waste; treatment and disposal options

UNIT 4: Hazardous Waste Management – Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects

UNIT 5: Radioactive Waste Management – Fundamentals Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options

UNIT 6: Environmental Risk Assessment Defining risk and environmental risk; methods of risk assessment; case studies. Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation

UNIT 7: Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation

UNIT 8: Landfill design Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration

References:

1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.

2. LaGrega, M. D. Buckingham, P. L. Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994.

3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997.

OEC-RAI-510 AIR AND NOISE POLLUTION AND CONTROL

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Objective: This course provides a comprehensive overview of air and noise quality and the science and technology associated with the monitoring and control

Course Outcomes (COs): After completing this course, the students will be able to:

CO1 - Identify the sources of air and noise pollution

CO2 - Monitor the ambient air quality

CO3 - Understand the concepts involved in control technologies.

Course Contents:

UNIT 1: Air pollution: composition and structure of atmosphere, global implications of air pollution. Classification of air pollutants: particulates, hydrocarbon, carbon monoxide, oxides of sulphur, oxides of nitrogen and photo chemical oxidants. Indoor air pollution,Effects of air pollutants on humans, animals, property and plants.

UNIT 2: Air pollution chemistry, meteorological aspects of air pollution dispersion; temperaturelapse rate and stability, wind velocity and turbulence, plume behaviour, dispersion of air pollutants, the Gaussian Plume Model, stack height and dispersion.

UNIT 3: Ambient air quality and standards, air sampling and measurements; Ambient air sampling,collection of gaseous air pollutants, collection of particulate air pollutants, stack sampling. Control devices for particulate contaminants: gravitational settling chambers, yclonee separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP).

UNIT 4: Control of gaseous contaminants: Absorption, Adsorption, Condensation and Combustion,Control of sulphur oxides, nitrogen oxides, carbon monoxide, and

hydro carbons.Automotive emission control, catalytic convertor, Euro-I, Euro-II and Euro-IIIspecifications, Indian specifications.

UNIT 5: NOISE POLLUTION: Basics of acoustics and specification of sound; sound power, soundintensity and sound pressure levels; plane, point and line sources, multiple sources; outdoorand indoor noise propagation; psycho-acoustics and noise criteria, effects of noise onhealth, annoyance rating schemes; special noise environments: Infra-sound, ultrasound,impulsive sound and sonic boom; noise standards and limit values; noise instrumentationand monitoring procedure. Noise indices.

Recommended/ Reference Books:

1. Peavy, Rowe and Tchobanoglous: Environmental Engineering.
2. Martin Crawford: Air Pollution Control Theory.
3. Warkand Warner: Air Pollution: Its Origin and Control.
4. Rao and Rao: Air Pollution Control Engineering.
5. Keshav Kant and Rajni Kant, "Air Pollution and Control Engineering", Khanna Publishing House.
6. Environmental Pollution Control Engineering-CS Rao, Wiley Eastern Ltd., New Delhi, 1996.
7. C.S. Rao, Air pollutionand control
8. Environmental Noise Pollution – PE Cunniff, McGraw Hill, New York, 1987
9. Nevers: Air Pollution Control Engineering.
10. M. P. Poonia and S C Sharma," Environmental Engineering, Khanna Publishing House.
11. My cock, Mc Kenna and Theodore: Handbook of Air Pollution Control Engineering and Technology. Suess and Crax ford: W.H.O. Manualon Urban Air Quality Management
12. O.P. Gupta, Elements of Environmental Polluton Control, Khanna Publishing House.

COURSES OFFERED BY ELECTRICAL ENGINEERING DEPARTMENT

(OPEN ELECTIVE COURSES-OEC-II)

ELPE411 ELECTRICAL ENERGY CONSERVATION AND AUDITING

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Outcomes: At the end of this course, students will demonstrate the ability to

CO1 Understand the current energy scenario and importance of energy conservation.

CO2 Understand the concepts of energy management.

CO3 Understand the methods of improving energy efficiency indifferent electrical systems.

CO4 Understand the concepts of different energy efficient devices.

Course Contents:

Unit 1:

Energy Scenario (6 Hours)

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Unit 2:

Basics of Energy and its various forms (7 Hours): Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

Unit 3:

Energy Management & Audit (6 Hours): Definition, energy audit, need, types of energy audit. Energy management (audit) approach- understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel energy substitution, energy audit instruments. Material and Energy balance: Facility as an
energy system, methods for preparing process flow, material and energy balance diagrams.

Unit 4: Energy Efficiency in Electrical Systems (7 Hours)

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficientmotors.

Unit 5: Energy Efficiency in Industrial Systems (8 Hours)

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Unit 6: Energy Efficient Technologies in Electrical Systems (8Hours)

Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Text/Reference Books

1. Guide books for National Certification Examination for Energy Manager / EnergyAuditors Book-1, General Aspects (availableonline)
2. Guide books for National Certification Examination for Energy Manager / EnergyAuditors Book-3, Electrical Utilities (availableonline)
3. S. C. Tripathy, “Utilization of Electrical Energy and Conservation”, McGraw Hill,1991.
4. Success stories of Energy Conservation by BEE, New Delhi(www.bee-india.org)

ELPE412 INDUSTRIAL ELECTRICAL SYSTEMS

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbolsand drawings, SLD.
2. Understand various components of industrial electricalsystems.
3. Analyze and selectthe proper size of various electrical systemcomponents.

Unit 1: Electrical System Components (8 Hours)
LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

Unit 2: Residential and Commercial Electrical Systems (8 Hours)
Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Unit 3: Illumination Systems (6 Hours)
Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Unit 4: Industrial Electrical Systems I (8 Hours)
HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Unit 5: Industrial Electrical Systems II (6 Hours)
DG Systems, UPS System, Electrical Systems for the elevators, Battery banks,
Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Unit 6: Industrial Electrical System Automation (6 Hours)
Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

Text/Reference Books

1. S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating &Costing”, Khanna publishers, 2008.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.
3. S. Singh and R. D. Singh, “Electrical estimating and costing”, DhanpatRai and Co., 1997. Web site for IS Standards.
4. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.

ELPE612 ELECTRICAL AND HYBRID VEHICLES

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the models to describe hybrid vehicles and their performance.
2. Understand the different possible ways of energy storage.
3. Understand the different strategies related to energy storage systems.

Unit 1: Introduction (10 hours)

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive- train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit 2: Electric Trains (10 hours)

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive- train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit 3: Energy Storage (10 hours)

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Unit 4: Energy Management Strategies (9 hours)

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

References:

1. C.Mi,M.A.MasrurandD.W.Gao,“HybridElectricVehicles:PrinciplesandApplicationswit h Practical Perspectives”, John Wiley & Sons,2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: EnergyManagement Strategies”, Springer,2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press,2004.
4. T. Denton, “Electric and Hybrid Vehicles”, Routledge,2016.

ELPE614 WIND AND SOLAR ENERGY SYSTEMS

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
2. Understand the basic physics of wind and solar power generation.
3. Understand the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems.

Unit 1: Physics of Wind Power: (5 Hours)

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Unit 2: Wind generator topologies: (12 Hours)

Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent- Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.

Unit 3: The Solar Resource: (3 Hours)

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Unit 4: Solar photovoltaic: (8 Hours)

Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

Unit 5: Network Integration Issues: (8Hours)

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Unit 6: Solar thermal power generation: (3 Hours)

Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

Text / References:

1. T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd.,2005.
2. G. M. Masters, “Renewable and Efficient Electric Power Systems**”,** John Wiley and

Sons,2004.
3. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill,1984.
4. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd.,2006.
5. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications,2004.
6. J.A.DuffieandW.A.Beckman,“SolarEngineeringofThermalProcesses”,JohnWiley&Sons , 1991.

COURSES OFFERED BY ELECTRONICS ENGINEERING DEPARTMENT
(OPEN ELECTIVE COURSES-OEC-II)

OEC-RAI-606 MICROPROCESSORS AND INTERFACING

No. of Credits: 3				Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total :	100 Marks
				Duration of Exam:	3 Hours

Course Objectives:

- To introduce the architecture and Operations of 8085 and 8086 microprocessor
- To study the addressing modes, instruction set and programming of 8085 & 8086.
- To introduce the various types of interrupts of 8085 and 8086 microprocessor
- To introduce various peripheral devices (8255, 8254, 8259 and 8257)
- To introduce various methods of interfacing of Peripherals with 8085/8086 microprocessor.

Course Outcomes:

On successful complete of this course, the students should be able to:

- Understand the architecture and Operations of 8085 and 8086 microprocessor
- Understand the addressing modes, instruction set and programming of 8085 & 8086.
- Understand the various types of interrupts of 8085 and 8086 microprocessor
- Understand various peripheral devices (8255, 8254, 8259 and 8257)
- Understand various methods of interfacing of Peripherals with 8085/8086 microprocessor

Syllabus

PART A

UNIT 1. ARCHITECTURE OF 8085:

Functional block diagram—Registers, ALU, Bus systems. Pin configuration, Timing and control signals, Machine cycle and timing diagrams. Interrupts—Types of interrupt, interrupt structure.

UNIT 2. PROGRAMMING OF 8085:

Instruction format, Addressing modes, Instruction set. Development of assembly language programs.

PART B

UNIT 3. INTERFACING DEVICES:

(a).The 8255 PPI chip: Architecture, pin configuration, control words, modes and Interfacing with 8085. (b). The 8254 PIC chip: Architecture, pin configuration, control words, modes and Interfacing with 8085.

UNIT 4. INTERRUPT AND DMA CONTROLLER:

(a). The 8259 Interrupt controller chip: Architecture, pin configuration, control words, modes

(b). The 8257 DMA controller chip: Architecture, pin configuration, control words, modes

PART C

UNIT 5. ARCHITECTURE OF 8086:

Functional block diagram of 8086, details of sub-blocks such as EU, BIU, memory segmentation, physical address computations, pin configuration, program relocation, Minimum and Maximum modes of 8086— Block diagrams and machine cycles. Interrupts— Types of interrupt, interrupt structure.

UNIT6. PROGRAMMING OF 8086:

Instruction format, Addressing modes, Instruction set. Development of assembly language programs, Assembler directives.

TEXT BOOKS:

1. Microprocessor Architecture, Programming & Applications with 8085: Ramesh S Gaonkar; Wiley Eastern Ltd.

2. Advanced Microprocessors and Peripherals by AK Ray & KM Bhurchandi, TMH Publications

REFERENCE BOOKS:

1. Microprocessors and interfacing: Hall; TMH

2. The 8088 & 8086 Microprocessors-Programming, interfacing, Hardware& Applications: Triebel & Singh; PHI

3. Microcomputer systems: the 8086/8088 Family: architecture, Programming & Design: Yu-Chang Liu & Glenn A Gibson; PHI. 4. Advanced Microprocessors and Interfacing: Badri Ram; TMH

OEC-RAI- 608 DIGITAL SIGNAL PROCESSING

No. of Credits: 3				Sessional:	25 Marks
L	T	P	Total	Theory:	75 Marks
3	0	0	3	Total :	100 Marks
				Duration of Exam:	3 Hours

Course Objectives:

• To introduce the students about various types of signals and their representation.

• To introduce the students about Discrete-Time Systems

• To introduce the students about sampling of signals

• To introduce the students about z-transform and its properties

• To introduce the students about various types of filters and their structures.

• To introduce the students about multirate digital signal processing

Course Outcomes:

On successful complete of this course, the students should be able to:

1. Understand about various types of signals and their representation and their implementation on MAT LAB.
2. Understand Discrete-Time Systems, sampling of signals and their implementation on MAT LAB.
3. Understand z-transform, its properties and their implementation on MAT LAB.
4. Understand various types of filters, their structures and their implementation on MAT LAB.
5. Understand multirate digital signal processing multirate digital signal processing

SYLLABUS

UNIT 1.

DISCRETE-TIME SIGNALS:

Signal classifications, frequency domain representation, time domain representation, representation of sequences by Fourier transform, properties of Fourier transform, discrete time random signals, energy and power theorems.

UNIT 2.

DISCRETE-TIME SYSTEMS:

Classification, properties, time invariant system, finite impulse Response (FIR) system, infinite impulse response (IIR) system

UNIT 3.

SAMPLING OF TIME SIGNALS:

Sampling theorem, application, frequency domain representation of sampling, reconstruction of band limited signal from its samples. Discrete time processing of continuous time signals, changing the sampling rate using discrete time processing.

UNIT 4.

Z-TRANSFORM:

Introduction, properties of the region of convergence, properties of the Z-transform, inversion of the Z transform, applications of Z-transform.

UNIT 5.

BASICS OF DIGITAL FILTERS:

Fundamentals of digital filtering, various types of digital filters, design techniques of digital filters : window technique for FIR, bi-linear transformation and backward difference methods for IIR filter design, analysis of finite word length effects in DSP,FIR &IIR Filter structure-direct1,direct2,cascade and parallel, Application of DSP.

UNIT 6.

MULTIRATE DIGITAL SIGNAL PROCESSING:

Introduction to multirate digital signal processing, sampling rate conversion, filter structures, multistage decimator and interpolators, digital filter banks.

TEXT BOOKS :

1. Digital Signal Processing : Proakis and Manolakis; PHI

2. Digital Signal Processing: Salivahanan, Vallavaraj and Gnanapriya;TMH

REFERENCE BOOKS:

1. Digital Signal Processing: Alon V. Oppenhelm;PHI

2. Digital Signal processing(II-Edition): Mitra, TMH

OEC-RAI-610 INSTRUMENTATION AND CONTROL

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

UNIT 1.

UNITS STANDARDS AND ERRORS:

S.I. units, Absolute standards (International, Primary, Secondary, and Working standards),True Value, Errors(Gross, Systematic and Random); Static Characteristic of instruments(Accuracy, Precision, Sensitivity, Resolution and threshold)

UNIT 2.

MEASURING INSTRUMENTS:

Construction, Operating principle , torque equation , shape of scale , use as Ammeter or as voltmeter (Extension of range) , use on AC / DC or both , advantages and disadvantages, errors(both on AC/DC)of PMMC types, electrodynamic type, moving iron type(attraction , Repulsion and combined attraction, repulsion types). Hot Wire type and induction type, electrostatic type instruments.

UNIT 3.

TRANSDUCERS:

Transducers Measurement of Temperature, RTD, Thermistors, LVDT, Strain Gauge, Piezoelectric Transducers, Digital Shaft Encoders, Tachometer, Hall effect sensors.

UNIT 4.

MATHEMATICAL MODELING:

Introduction, Control System, Types of Control Systems, Servo-mechanism, Mathematical Model of a System, Mathematical Modelling of Mechanical Systems, , Mathematical Modelling of Electrical Elements, Analogous Systems, Block Diagram Algebra, Signal Flow Graphs,

UNIT 5. TIME DOMAIN ANALYSIS:

Introduction, Time Response, Standard Test Signals, Transfer Function, S – Plane, First Order System, Time Response of First Order System, Speed of Response, Unit Ramp

Response of a First Order System, Second Order System, Impulse Response of Second – Order System, Unit Step Response of a Second Order System, Time Domain Specifications, Steady State Error and Error Constants, Type of Feedback Control Systems, Effect of Adding a Zero to a System.

UNIT 6. Compensation, PID Controller.

TEXT BOOK:

1. A course in Electrical & Electronics Measurements &Instrumentation :A.K .Sawhney; Dhanpat Rai& Sons.

2. Control System Engineering : I.J.Nagrath & M. Gopal; New Age

3. Modern Control Engg : K.Ogata; PHI.

REFERENCE BOOKS.

1. Electronics Instrumentation & Measurement Techniques : Cooper; PHI.

OEC-RAI-612 DATA COMMUNICATION AND NETWORKING

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Objectives:

- To make students know about the data communication and networking
- To make students know about digital data communication
- To make students know about data Link Control, Link Configurations and Protocol principles
- To provide students mathematical formulations and the derivations of various parameters
- To make students know about Communication Networking Techniques
- To make students know about Computer Communication Architecture and ISDN Networks

Syllabus

Unit 1.

Introduction to Data Transmission: Overview of Data Communication and networking, Analog and Digital Data Transmission, Transmission Impairments, Various Transmission Media, Data Encoding.

Unit 2.

Digital Data Communication Techniques: Asynchronous and Synchronous Transmission, Error Detection and correction techniques, Physical interfaces

Unit 3.

Data Link Control: Link Configurations, Protocol principles (Error control, Flow control), Bit Oriented and character oriented protocol, Data link layer services, Link Control.

Unit 4.

Multiplexing: F.D.M. Synchronous TDM, Statistical TDM

Unit 5.

Communication Networking Techniques: Communication Networks, Circuit Switching, Message Switching, Packet Switching, Local Networking Technology, The bus / tree topology, the ring topology, Medium Access control protocols (CSMAlCD, Token ring, FDDI, DQDB).

Unit 6.

Computer Communication Architecture: OSI and TCP/IP Model, Protocol and Architecture, Networking Access protocols, Inter Networking, Transport layer Protocols, Session Service and Protocols, and Presentation! Application protocols

Unit 7.

ISDN Networks: Concepts and Architecture, Protocols

Text Books:

1. William Stallings, "Data and Computer Communication", PHI, 4th Ed.
2. Forouzan, "Data communications and networking", TMH

Reference Books:

1. Andrew Tanenbaum, "Computer Networking", PHI
2. Godbole, "Data communications and network", TMH

Course Outcomes: On successful complete of this course, the students should be able to:

1. Understand about the data communication and networking
2. Understand about digital data communication
3. Understand about data Link Control, Link Configurations and Protocol principles
4. Understand about mathematical formulations and the derivations of various parameters Understand about Communication Networking Techniques
5. Understand about Computer Communication Architecture and ISDN Networking

COURSES OFFERED BY HAS DEPARTMENT
(OPEN ELECTIVE COURSES-OEC-III)

OEC-RAI-442 SOFT SKILLS FOR ENGINEERS

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Objectives (CO):

1. To equip students with the ability to handle corporate interaction and business communication well by making them conversant with various forms and norms of formal communication.
2. Furthermore, the objective is to guide the students to use communication for leadership and team-building.
3. Ultimately, to convey an idea about operation of social responsibility models and international bodies that bring technology to the service of society, thus, giving our students an ability to discuss larger issues pertaining to technological progress.
4. Since the urge to convey emerges in chosen area of interest and social concerns-emergent issues in science form the basis for interpersonal discussions and soft skills development.

Unit-I-

CRITICAL THINKING & BEHAVIORAL SKILLS: Importance of Scientific Aptitude; SWOC & STEP; Scientific Temper; Logical Fallacies; Positive Attitude, Problem Solving Skills; Ways to Argue Politely; Group Discussions, Corporate Dialogue/Role Play Conflict and Resolution.

Unit-II-

LEADERSHIP & PARTICIPATION: Leadership skills, Attitudes, Sensitivity training. Learning/'Take-aways' from scenarios/situations; Communication Skills; Seven Cs of Communication; Barriers to Effective Communication; Crisis-handling; Negotiation-Conflict resolution exercises.

Unit –III-

CREATIVE COMPOSITION&TECHNICAL WRITING: Exercises in creative writing: USP and image building; Setting Goals; Charting Objectives; Hypothesis; Thesis; Writing Abstracts; Reports; Resume and Covering Letter.

Unit-IV-

CORPORATE INTERACTION & COMMUNICATION: Review of social, political and corporate scene; Group Discussions with prior briefs on CSR and IPR and role of important international bodies like WTO and IMF; Presentations; Technical/Business vocabulary; Body Language; Presentation Skills; Mock-interviews.

Course Outcome:

1. Students will be able to connect science and technology with society.
2. Students will learn to prepare for Group Discussions and thus, be able to perform well in discussions, debates and interviews; students will understand forms of corporate communication and learn about formats and layouts of report writing and other forms of business communication.
3. Students will learn about conflict negotiation and crisis handling.
4. Students will have emulated good communication practices for better leadership and team-building.

References:

Stephen Robbins and Seema Sanghi. Organizational Behaviour. Pearson. Latest edition.

Kotler, Philip and Kevin Lane Keller. Marketing Management. 13 th edition.2008 Eastern Economy Edition

Wehmeier, Sally .*Oxford Advanced Learner's Dictionary*. Oxford UP.2005

Ghosh, BN. Managing Soft Skills for Personality Development. Tata McGraw-Hill 2012

Rizvi, M Ashraf. *Effective Technical Communication*. Tata Mc Graw-Hill.2005

Bretag, Crossman and Bordia. Communication Skills. Tata Mc Graw-Hill.2009

Sites: Youtube and Wikipedia in general.

OPHL-306A PHYSICS AND OUR WORLD

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

COURSE OBJECTIVE

The course aims to provide the students fundamentals of Physics and of our world

UNIT-I:

Space and Time:A discussion on length scales and dimensions, Galaxies, The solar system and the planet Earth, Rotation and Revolution of the Earth, Seasons, Calendars in History and the recording of time, Laws of motions- A Discussions of principles, theories and models, Gravitation, Planetary motion and Keplar's Laws, the laws of motion in the eyes of Galileo and Newton.

UNIT-II:

Theory of Relativity: The relationship between Space and time: A basic account of theory of Relativity, Does nature differentiate between left and right?- The notion of Parity, Is there an "Arrow" of time?. Entropy and Laws of Thermodynamics, The Size of the Universe- Is the Universe expanding?

UNIT-III:

Matter and Energy: Discrete and continuous matter- a brief historical survey, Atoms and molecule: Structure of atoms, the nucleus, Elementary particles, Unification of forces. Equivalence of matter and energy, Nuclear energy and thermodynamics power. The Periodic table of elements, chemical bonds and molecules, Large molecules and living matter.

UNIT-IV

Electromagnetic Energy: Waves and oscillations, Electromagnetic radiation and spectrum, Propagation of waves, Energy in the atmosphere- Wind and solar energy, Weather predictability and chaos, Indeterminacy, The quantum world—an introduction, Debates on the conceptualization of physical realities- is nature unreasonably mathematical?

COURSE OUTCOME

On successful completion of this course, students should be able to :

- Understand the relation between space and time.
- Learn the about the elementary particles and equivalence of energy and matter
- Learn about matter and energy
- Comprehend the basics of Electromagnetic energy

REFERENCE BOOKS:

1. The Evolution of Physics-Einstein and L. Infeld, Toughstone 1967
2. The Ascent of Man-J. Bronowski, laffle and Brown Company, 1976
3. Commos- Carl sagan, McDonald and Company, 2003.

OPHL-305A INTRODUCTION TO ASTROPHYSICS AND COSMOLOGY

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total: 100 Marks
	Duration of Exam: 3 Hours

COURSE OBJECTIVE:

To show how the properties of astronomical objects and the Universe relate to simple physical laws and processes

COURSE OUTCOMES

On completion successful students will be able to:

1. Have an understanding of the role and physics of detectors and telescopes including geometric optics and understand how distances are measured.
2. Know how basic laws of physics determine the properties and evolution of stars.
3. Know Kepler's Laws and how they relate to extrasolar planet detection.
4. Understand how the dynamics of galaxies indicate the presence of dark matter and demonstrate an understanding of the evolution of our Universe.

SYLLABUS

UNIT I:

The Universe and its physics: A tour of the Universe, its scale and contents; Gravity; Pressure; Radiation Observational astronomy: the electromagnetic spectrum; geometrical optics; resolving power, and the diffraction limit; telescopes and detectors; gravitational waves; Distances: parallax measurements, standard candles

UNIT II:

Physics of the Sun and Stars: blackbody radiation, the Planck, Stefan-Boltzmann and Wien laws, effective temperature, interstellar reddening; hydrogen spectral lines and Doppler effect; Hertzprung-Russell diagram; Freefall and Kelvin-Helmholtz time; nuclear fusion; basic stellar structure (hydrostatic equilibrium, equation of state); white dwarfs, neutron stars and black holes

UNIT III:

Planetary systems: Kepler's laws; Detection methods of extrasolar planets; search for life elsewhere.

UNIT IV:

Star formation: the interstellar medium; stellar populations; the interstellar medium; galaxy rotation curves, mass and dark matter; Galaxy collisions; central engines; Cosmology: Olber's paradox, Hubble's Law; the age of the Universe; Evolution of the Universe: Madau diagram; Evidence for the Big Bang (blackbody radiation, nucleosynthesis); dark energy and the accelerating Universe.

References:

1. Carroll, B.W. & Ostlie, D.A., *An Introduction to Modern Astrophysics* (Pearson

OES-301A WASTE MANAGEMENT IN OUR DAILY LIFE

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total: 100 Marks
	Duration of Exam: 3 Hours

COURSE OBJECTIVES

The course aims at to provide knowledge about characteristics and types of solid waste generated
in our daily life. The students will be able to learn various methods for waste processing, prevention, treatment and final disposal and may apply in their daily life.

COURSE OUTCOMES:

After completing this course, the students will be able to:
- Understand the characteristics and types of solid waste.
- Know about various methods for waste processing and prevention.
- Apply the knowledge for waste treatment.
- Get knowledge of final disposal of wastes in daily life.

UNIT 1: WASTE

What is waste? Sources of waste generation; Composition and classification of waste; Sorting and segregation of waste at source of generation (kitchen, garden, residential colonies and commercial areas); waste collection – sample collection bins; storage and transport.

UNIT 2: WASTE PROCESSING AND PREVENTION

Waste prevention and recycling at home, small communities; reduce, recycle and reuse; Waste processing – size and volume reduction.

UNIT 3: WASTE TREATMENT

Safe disposal of waste; open dumping, problems of open dumping and burning; landfills; diseases associated with waste handling; Best practices for solid waste disposal

UNIT 4: DISPOSAL OF WASTE

Composting – vermicomposting, kitchen garden; anaerobic digestion – biogas, manure; waste to energy – pyrolysis, refuse derived fuels.

REFERENCES:

1. Ramachandra T.V., (2009), *Management of municipal solid waste*, published by TERI Press,
New Delhi.
2. Williams, P. T. Williams A. (2005), *Waste treatment and disposal*, 2nd Edition Wiley publications, UK.
3. Dhamija, U., (2009). *Sustainable solid waste management: issues, policies, and structures*. Academic Foundation, New Delhi.

OES- 302A ENVIRONMENTAL CONSERVATION

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

COURSE OBJECTIVES:

The course provides students a comprehensive review of our natural resources including land, water, energy, biodiversity, etc. The students will be able to understand the importance of natural resource management and market based mechanisms for environment protection.

COURSE OUTCOMES:

After completing this course, the students will be able to:

- Understand about various natural resources.
- Know about various methods for soil and water conservation.
- Apply the knowledge for biodiversity conservation.
- Get knowledge of energy conservation.

UNIT 1: INTRODUCTION

Man and environment, Importance of environmental conservation, natural resources, waste as a
resource.

UNIT 2: SOIL AND WATER CONSERVATION

Land degradation, soil erosion, conservation measures – afforestation, mulching, Soil fertility restoration - organic manure application, need for sustainable water management, judicious water consumption at home, measures for effective irrigation – sprinkler, drip, watershed management, rain water harvesting, indigenous micro-irrigation devices. Evaluation of water footprints – A case study.

UNIT 3: BIODIVERSITY CONSERVATION

Significance of biodiversity conservation, threats to biodiversity – pollution, population, habitat destruction, overexploitation, man- wildlife conflicts, strategies for biodiversity conservation -

garden – herbal, ornamental, kitchen, organic farming and biodiversity conservation, conservation farming, national parks, sanctuaries, zoo, botanical gardens, Forest and wildlife conservation.

UNIT 4: ENERGY CONSERVATION

Ways to conserve energy at home, offices, buildings, energy efficiency – electrical appliances,

CFL, LEDs, OLEDs, clean fuels for vehicles. Evaluation of carbon footprints – A case study.

REFERENCES:

1. Ahluwalia, V.K. Environmental Studies : Basic concepts, TERI, 2013.

2. Beheim, Einar (Ed.) Integrated watershed management : perspectives and problems, Springer, 2010.

3. Bhatt, S. Environment protection and sustainable development, APH Publishing Corporation,2004.

4. Burchett, Stephen. Introduction to wildlife conservation in farming, Wiley- Blackwell, 2010.

5. Das, S.K. Watershed development and livelihoods: People's action in India,Routledge India,2007.

6. Fa, John E. Zoo Conservation Biology (Ecology, Biodiversity and Conservation), Durrell Wildlife Conservation Trust, 2011.

7. Fatik B. Mandal. And Nepal C. Nandi. Biodiversity: concepts, conservation and biofuture, Asian Books, 2013

8. Heathcote, Isobel W. Integrated watershed management: principles and practice (2nd Ed), John Wiley & Sons, 2009

9. Prasad, Govid Conservation of natural Resources, Discovery Publishing, New Delhi,2013.

10.Srivastav, Sweta. Basics of Environmental Science, Anmol Publications Pvt Ltd, 2008.

COURSES OFFERED BY MANAGEMENT DEPARTMENT
(OPEN ELECTIVE COURSES-OEC-III)

OEC-RAI-444 HUMAN RESOURCE MANAGEMENT

No. of Credits: 3	Sessional: 25 Marks
L T P Total	Theory: 75 Marks
3 0 0 3	Total : 100 Marks
	Duration of Exam: 3 Hours

Course Objectives:

The primary concern of this course is to sensitize students to the various facts of managing people and to create an understanding of the various policies and practices of human resource management.

Course Outcomes: After completing this course, the students will be able to;

CO1- Understand the basics of HRM with roles and responsibilities of a manager.

CO2- Meet HR challenges in present scenario

CO3- Employ, maintain and promote a motivated force in an organization.

CO4 - Be aware about contemporary issues of human resource management.

UNIT 1:

Human Resource Management: concept and scope; Roles, responsibilities and competencies of HR manager; Challenges to HR professionals; Human Resource Planning & Forecasting: significance and process.

UNIT 2:

HR Sourcing: Recruitment, Selection and Induction. Job Analysis: job Description and job Specification; Job Design: concept and methods; Job Evaluation-concept &methods; Performance appraisal and counselling.

UNIT 3:

Training: training process and methods; Career planning and Development; Succession planning; Employee Compensation: basic concepts & determinants;

UNIT 4:

Industrial Relations and Grievance Handling; Employee welfare; Dispute Resolution; International Human Resource Management; Contemporary Issues in HRM. HR Audit &Accounting, ethics & corporate social responsibility.

Text Books/ Reference Books:

1. K. Aswathapa Human resource Management: Text and cases, 6th edition, Tata McGraw Hill, New Delhi,2012

2. Uday Kumar Haldar &Juthika Sarkar(2012) Human resource Management New Delhi, Oxford University Press.

3. De Cenvo, Da & Robbins S.P.(2010) Fundamentals of Human Resource Management, 9th edition, New York, John Wiley & Sons.

4. Gary Dessler (2008) Human Resource Management, 11th edition New Delhi: Pearson Prentice Hall. 5. Tanuja Agarwala, Strategic Human resource Management, Oxford University Press 2007.

OEC-RAI-446 FINANCE AND ACCOUNTING

No. of Credits: 3		Sessional:	25 Marks
L T P	Total	Theory:	75 Marks
3 0 0	3	Total:	100 Marks
		Duration of Exam:	3 Hours

Course Objectives:

The purpose of the course is to understand nature of accounting and its interaction with other accounting and their comparison. It also focuses what kind of information the managers need, from where these can be obtained and how this information can be used to carry out important managerial decision.

UNIT-1:

Meaning nature and scope of different types of accounting and their comparison. Accounting principles and Indian accounting standards, IFRS, Preparation of final accounts of company with basic adjustments. Reading and understanding of Annual report.

UNIT-2:

Analysis and interpretation of financial statements – meaning, importance and techniques, ratio analysis; fund flow analysis; cash flow analysis (AS-3)

UNIT-3:

Classification of costs, preparation of cost sheet, inventory valuation, overview of standard costing and variance analysis; material variance and labour variance.

UNIT-4:

Budgetary control- meaning, need, objectives, essentials of budgeting, different types of budgets cash budget, flexible budget zero base budget; marginal costing, BEP analysis, decision making for optimum sales mix, exploring new markets, make/Buy decisions, expand/ contract, accepting and rejecting decisions

Course Outcomes:

1. This course will impart knowledge to the students regarding preparation of financial statements their analysis.
2. The students will be able to understand applications of cost accounting and cost control techniques like standard costing etc.

3. The course will help them to take better managerial decisions.
4. Students will be able to know about budget control techniques.

REFERENCES:

1. Singhal, A.K. and Ghosh Roy, H.J., Accounting for Managers, JBC Publishers and Distributors, New Delhi
2. Pandey, I.M., Management Accounting, Vikas Publishing House, New Delhi
3. Horngren, Sundem and Stratton, Introduction to Management Accounting, Pearson Education, New Delhi.
4. Jain, S.P and Narang, K.L., Advanced Cost Accounting, Kalyani Publishers, Ludhiana.
5. Khan, M.Y. and Jain, P.K., Management Accounting, TMH, New Delhi

OEC-RAI-450 ENTREPRENEUR DEVELOPMENT

No. of Credits: 3		Sessional:	25 Marks
L T P Total		Theory:	75 Marks
3 0 0 3		Total :	100 Marks
		Duration of Exam:	3 Hours

Course Objectives:

The aim of this course is to provide know-how for being able to start a new entreprise by identifying the entrepreneurial opportunities, support and resource requirements.

Course Outcomes: At the end of the course, the student shall be able to:

CO 1-Acquire knowledge about entrepreneur and entrepreneurship.

CO 2- Understand the various activities involved in establishment of a business.

CO 3-Identify the environmental and operational issues of a business enterprise.

CO 4-Understand the government role and appraisal methods and growth strategies.

Course Contents:

UNIT 1:

Concept of Entrepreneur, Characteristics, qualities and pre-requisites of entrepreneur, entrepreneurship and intrapreneur, Entrepreneur vs. Manager; Economic, social and psychological need for entrepreneurship;

UNIT 2:

Environmental Factors affecting success of a new business, Formulation of business plan, Contents and significance of business plan

UNIT 3:

Feasibility Study -Preparation of Feasibility Reports: Economic, Technical, Financial and Managerial Feasibility of Project, Methods and procedures to start and expand one's own business

UNIT 4:

Role of Government and Promotional agencies in entrepreneurship development, Entrepreneurship Development Programmes

Reference Books:

- Khanka S.S., “Entrepreneurship Development”. S.Chand.
- Desai, A N. "Entrepreneur & Environment". 1990. Ashish, New Delhi.
- Drucker, Peter. "Innovation and Entrepreneurship". 1985. Heinemann, London.
- Jain Rajiv. "Planning a Small Scale Industry: A Guide to Entrepreneurs". 1984. S.S. Books, Delhi.
- Kumar, S A. "Entrepreneurship in Small Industry". 1990, Discovery, New Delhi.
- McClelland, D C and Winter, W G. "Motivating Economic Achievement". 1969. Free Press, New York.
- Pareek, Udai and VenkateswaraRao, T. "Developing Entrepreneurship -A Handbook on Learning Systems". 1978, Learning Systems, Delhi.

OEC-RAI-452 ECONOMICS FOR ENGINEERS

No. of Credits: 3		Sessional:	25 Marks
L T P	Total	Theory:	75 Marks
3 0 0	3	Total :	100 Marks
		Duration of Exam:	3 Hours

Course Outcomes (COs):

1. The course will impart knowledge of economic forces influencing an organisation
2. This course will enable students to take decisions on the basis of interaction of market
3. The course will help students to be efficient engineers by utilizing limited resources to satisfy unlimited wants
4. The course will enable students to take decisions regarding price determination on the basis of market structure.

Course Contents:

Unit 1

Introduction to the subject: Micro and Macro Economics, Relationship between Science, Engineering, Technology and Economic Development. Production Possibility Curve, Nature of Economic Laws.

Unit 2

Time Value of Money: concepts and application. Capital budgeting; Traditional and modern methods, Payback period method, IRR, ARR, NPV, PI (with the help of case studies)

Unit 3

Meaning of Demand. Law of Demand, Elasticity of Demand; meaning, factors effecting it and its practical application and importance. Demand forecasting (a brief explanation)

Unit 4

Meaning of Production and factors of production, Law of variable proportions and returns to scale. Internal and external economies and diseconomies of scale. Concepts of cost of production, different types of costs; accounting cost, sunk cost, marginal cost, Opportunity cost. Break even analysis, Make or Buy decision (case study). Relevance of Depreciation towards industry.

Unit 5

Meaning of market, types of market, perfect competition, Monopoly, Monopolistic, Oligopoly. (main features). Supply and law of supply, Role of demand and supply in price determination.

Unit 6

Indian Economy, nature and characteristics. Basic concepts; fiscal and monetary policy,

LPG, Inflation, Sensex, GATT, WTO and IMF. Difference between Central bank and Commercial banks

Recommended/ Reference Books:

1. Jain T.R., "Economics for Engineers", VK Publication
2. Chopra P. N., "Principle of Economics", Kalyani Publishers
3. Dewett K. K., "Modern economic theory", S. Chand
4. H. L. Ahuja., "Modern economic theory", S. Chand
5. Dutt Rudar & Sundhram K. P. M., "Indian Economy"
6. Mishra S. K., "Modern Micro Economics", Pragati Publications
7. Pandey I.M., "Financial Management"; Vikas Publishing House
8. Gupta Shashi K., "Management Accounting", Kalyani Publication

VALUE ADDED COURSES

CODE: HSMC (H-102)

UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

NO OF CREDITS: 0 **L T P T**

2 1 0 3

This value-added course is for UG/PG students. It may be taught through digital aided learning/class room teaching. Its duration is 35 hours. Minimum 75% attendance is compulsory for students and its evaluation will be done by concerned Dept. through Viva-Voce examination/internal examination.

Pre-requisites: None. Universal Human Values 1 (desirable)

Course Objectives:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Human Values Course

This course also discusses their role in their family. It, very briefly, touches issues related to their role in the society and the nature, which needs to be discussed at length in one more semester for which the foundation course named as "H-102 Universal Human Values 2: Understanding Harmony" is designed which may be covered in their III or IV semester. During the Induction Program, students would get and initial exposure to human values through Universal Human Values –I. This exposure is to be augmented by this compulsory full semester foundation course. **Universal Human Values 2: Understanding Harmony**

MODULE-1: COURSE INTRODUCTION - NEED, BASIC GUIDELINES, CONTENT AND PROCESS FOR VALUE EDUCATION

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; _Natural Acceptance' and Experiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority

5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario.
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

MODULE-2: UNDERSTANDING HARMONY IN THE HUMAN BEING - HARMONY IN MYSELF!

1. Understanding human being as a co-existence of the sentient ‗I' and the material ‗Body'
2. Understanding the needs of Self (‗I') and ‗Body' - happiness and physical facility
3. Understanding the Body as an instrument of ‗I' (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of ‗I' and harmony in ‗I'
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

MODULE-3: UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETYHARMONY IN HUMAN – HUMAN RELATIONSHIP

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students‘ lives

MODULE-4: UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS COEXISTENCE

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and selfregulation in nature
3. Understanding Existence as Co-existence of mutually interacting units in all pervasive space
4. Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film ―Home‖ can be used), pollution, depletion of resources and role of technology etc.

MODULE-:5 IMPLICATIONS OF THE ABOVE HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Course Outcomes: By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction. This is only an introductory foundational input. It would be desirable to follow it up by

a) faculty-student or mentor-mentee programs throughout their time with the institution

b) Higher level courses on human values in every aspect of living. e.g. as a professional

READINGS:

Text Book

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE BOOKS

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

ASSESSMENT

This is a compulsory non-credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by faculty mentor: 10 marks
Self –assessment: 10 marks
Assessment by peers: 10 marks
Socially relevant project/Group Activities/Assignments: 20 marks
Semester End Examination: 50 marks
The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

VAC01: HUMAN VALUES AND PROFESSIONAL ETHICS

NO OF CREDITS: 0 **L T P T**

2 1 0 3

This course may be taught through digital aided learning / classroom teaching. Its duration is 31-35 hours. Minimum 75% attendance is compulsory for students and its evaluation will be done by concerned Dept. through Viva-Voce examination. These are recommended in I year.

PROFESSIONAL ETHICS OBJECTIVES:

To enable the students to create an awareness on Ethics and Human Values, to instil Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I: HUMAN VALUES

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II: ETHICS

Senses of Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy –Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion.

UNIT III: PROFESSIONALS AS SOCIAL EXPERIMENTATION

Social Experimentation – Professionals as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV: SAFETY, RESPONSIBILITIES AND RIGHTS

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality –Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) Gender inequality , causes and consequences. Discrimination, Social understandings, Women and Men in the Organization, Consequences of sexual harassment.

UNIT V: GLOBAL ISSUES

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development

– Professionals as Managers – Consulting Engineers – Professionals as Expert Witnesses and Advisors Moral Leadership – Code of Conduct – Corporate Social Responsibility.

COURSE OUTCOMES: Upon completion of the course, the student should be able to:

CO1- Apply ethics in society

CO2- Discuss the ethical issues related to engineering.

CO3- Realize the responsibilities as a good citizen.

CO4- Realize the rights in the society.

TEXTBOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.

2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.

2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009

3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003

4. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001

5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.

Web sources:

1. www.onlineethics.org
2. www.globalethics.org
3. www.ethics.org

ANNEXURE-A

Courses in Syllabus having direct bearing on Employability/ Entrepreneurship/ Skill Development

Courses in Syllabus having direct bearing on Employability/ Entrepreneurship/ Skill development

S.No.	Course Code	Course Name	Employability	Entrepreneurship	Skill Development
1.	PCC-RAI-301/21	Materials Engineering	√	√	√
2.	PCC-RAI-302/21	Basics of Electronics Engineering	√		√
3.	PCC-RAI-303/21	Data Structure	√	√	√
4.	PCC-RAI-304/21	Digital Electronics		√	√
5.	PCC-RAI-305/21	Basics of Electronics Engineering Lab	√		√
6.	PCC-RAI-306/21	Data Structure Lab	√	√	√
7.	PCC-RAI-401/21	Kinematics of Robots	√	√	√
8.	PCC-RAI-402/21	Artificial Intelligence	√	√	√
9.	PCC-RAI-403/21	Design of Machine Elements	√	√	√
10.	PCC-RAI-404/21	Microprocessor and Microcontroller		√	√
11.	PCC-RAI-405/21	Mechatronics System Design	√	√	√
12.	PCC-RAI-406/21	Artificial Intelligence Lab	√	√	√
13.	PCC-RAI-407/21	Microprocessor and Microcontroller Lab	√	√	√
14.	PCC-RAI-408/21	Kinematics of Robots Lab	√	√	√
15.	PCC-RAI-501/21	CAD/CAM	√	√	√
16.	PCC-RAI-502/21	Digital Signal Processing	√	√	√
17.	PCC-RAI-503/21	Machine Learning and Application	√	√	√
18.	PCC-RAI-504/21	Communication Systems	√	√	√
19.	PCC-RAI-505/21	Design and Fabrication Lab	√	√	√
20.	PCC-RAI-506/21	Python Programming Lab	√	√	√
21.	PCC-RAI-601/21	Introduction to IOT	√	√	√
22.	PCC-RAI-602/21	Control Systems		√	√
23.	PCC-RAI-603/21	Soft Computing	√	√	√
24.	PCC-RAI-604/21	IOT Lab	√	√	√
25.	PCC-RAI-605/21	Control Systems Lab	√	√	√
26.	PCC-RAI-701/21	Additive Manufacturing	√	√	√
27.	PCC-RAI-702/21	Deep Learning Principles and Practices		√	√
28.	PCC-RAI-703/21	Mechanical Vibrations	√		√
29.	PCC-RAI-704/21	Additive Manufacturing Lab	√	√	√
30.	BSC-103RAI	Mathematics-I		√	√
31.	BSC-102	Chemistry		√	√
32.	BSC-105	Chemistry Lab		√	√
33.	BSC-101G	Physics (Electromagnetism and Basic Electronics)		√	√
34.	BSC-106RAI	Mathematics- II		√	√
35.	BSC-104A	Physics Lab		√	√
36.	BSC-301RAI	Mathematics-III		√	√

		(Linear Algebra and Numerical Methods)			
37.	BSC-01	Biology			√
38.	BSC-501RAI	Probability and Statistics	√	√	√
39.	ESC-101A	Basic Electrical Technology	√	√	√
40.	ESC-107A	Basic Electrical Technology Laboratory	√	√	√
41.	ESC-104A/21	Workshop- I	√	√	√
42.	ESC-103	Programming for Problem Solving	√	√	√
43.	ESC-105	Programming for Problem Solving Lab	√	√	√
44.	ESC-102A/21	Engineering Graphics and Drawing	√	√	√
45.	ESC-106A/21	Workshop- II	√	√	√
46.	ESC-303RAI/21	Engineering Mechanics	√	√	√
47.	HSMC-101	English	√	√	√
48.	HSMC-102	English Lab	√	√	√
49.	SEC-RAI-301/21	Project I	√	√	√
50.	SEC-RAI-401/21	Project II	√	√	√
51.	SEC-RAI-501/21	Project III	√	√	√
52.	SEC-RAI-601/21	Project IV	√	√	√
53.	SEC-RAI-701/21	Project V	√	√	√
54.	SEC-RAI-801/21	Industrial Training	√	√	√
55.	MC-02	Essence of Indian Traditional Knowledge		√	√
56.	MC-04G	Message of Bhagavad Gita	√	√	√
57.	MCEVS-01	Environment and Ecology		√	√
58.	MCEVS-02	National Resources and Biodiversity Conservation		√	√
59.	MCEVS-03	Environment Pollution, Waste Management and Sanitation		√	√
60.	HSMC (H-102)	Universal Human Values 2: Understanding Harmony	√	√	√
61.	VAC01	Human Values and Professional Ethics	√	√	√
62.	PEC-RAI-601/21	Software Engineering	√	√	√
63.	PEC-RAI-602/21	Operating System	√	√	√
64.	PEC-RAI-603/21	Theory of Optimization Techniques	√	√	√
65.	PEC-RAI-604/21	Cloud Computing	√	√	√
66.	PEC-RAI-611/21	Mobile Communication Network	√	√	√
67.	PEC-RAI-612/21	Wireless Communication	√	√	√
68.	PEC-RAI-613/21	Wireless Sensor Networks	√	√	√
69.	PEC-RAI-614/21	Smart Sensor and Sensor Network	√	√	√
70.	PEC-RAI-701/21	Operations Research	√	√	√

71.	PEC-RAI-702/21	Design Optimization	√	√	√
72.	PEC-RAI-703/21	Product Design and Development	√	√	√
73.	PEC-RAI-704/21	Total Quality Management	√	√	√
74.	PEC-RAI-705/21	Operations Management	√	√	√
75.	PEC-RAI-706/21	Value Engineering	√	√	√
76.	PEC-RAI-711/21	Metallurgy	√	√	√
77.	PEC-RAI-712/21	Composite Materials	√	√	√
78.	PEC-RAI-71321	Modeling, Simulation and Optimization	√	√	√
79.	PEC-RAI-714/21	Micro and Nano Manufacturing	√	√	√
80.	PEC-RAI-715/21	Introduction to NC, CNC Programming	√	√	√
81.	PEC-RAI-721/21	Process Planning and Cost Estimation	√	√	√
82.	PEC-RAI-722/21	Non-Conventional Energy Resources Utilization	√	√	√
83.	PEC-RAI-723/21	Manufacturing Processes	√	√	√
84.	PEC-RAI-724/21	Finite Element Analysis	√	√	√
85.	PEC-RAI-725/21	New Venture Creation	√	√	√
86.	OEC-RAI-502	Cyber laws and Security	√	√	√
87.	OEC-RAI-504	Web Technology and Information Retrieval	√	√	√
88.	OEC-RAI-505	Intellectual Property and Rights	√	√	√
89.	OEC-RAI-506	Basic Environmental Engineering	√	√	√
90.	OEC-RAI-507	Traffic Engineering and Management	√	√	√
91.	OEC-RAI-508	Contracts Management	√	√	√
92.	OEC-RAI-509	Solid and Hazardous Waste Management	√	√	√
93.	OEC-RAI-510	Air and Noise Pollution and Control	√	√	√
94.	ELPE411	Electrical Energy Conservation and Auditing	√	√	√
95.	ELPE412	Industrial Electrical System	√	√	√
96.	ELPE612	Electrical and Hybrid Vehicles	√	√	√
97.	ELPE614	Wind and Solar Energy System	√	√	√
98.	OEC-RAI-606	Microprocessor and Interfacing		√	√
99.	OEC-RAI-608	Digital Signal Processing		√	√
100.	OEC-RAI-610	Instrumentation and Control		√	√
101.	OEC-RAI-612	Data Communication and Networking		√	√
102.	OEC-RAI-442	Soft Skills for Engineers	√	√	√

103.	OPHL-306A	Physics and Our World	√		
104.	OPHL-305A	Introduction to Astrophysics and Cosmology	√		
105.	OES-301A	Waste Management in our Daily Life	√	√	√
106.	OES-302A	Environmental Conservation	√	√	√
107.	OEC-RAI-444	Human Resource Management	√	√	√
108.	OEC-RAI-446	Finance and Accounting	√	√	√
109.	OEC-RAI-450	Entrepreneur Development	√	√	√
110.	OEC-RAI-452	Economics for Engineers	√	√	√

ANNEXURE-B

FOR

MOOC COURSES

Implementation of Credit Transfer/Mobility Policy of online courses

Reference: Gazette of India (Extraordinary) Part-III, Section-4 No. 295, UGC (**Credit Framework for Online Learning Courses through SWAYAM) Regulation, 2016,** dated 19/07/2016.

With reference to 12th Academic Council Meeting dated 03/05/2017 (Agenda Item No. AC/11/12), wherein MOOCs were adopted in the CBCS scheme, In continuation to that, following modalities are proposed to introduce the credit transfer policy in academic curriculum for the Massive Open Online Courses (MOOC's) offered through SWAYAM (Study Webs of Active-Learning for Young Aspiring Minds) Portal.

A. General Guidelines

1. The SWAYAM shall notify in June and November every year, the list of the online learning Courses going to be offered in the forthcoming Semester on its website https://swayam.gov.in.

2. All the UTDs/Affiliated Colleges shall, within 4 weeks from the date of notification by SWAYAM, consider through their Chairperson/Principal the online learning courses being offered through the SWAYAM platform; and keeping in view their academic requirements, decide upon the courses which it shall permit for credit transfer and keeping in view the following points:

    a) There is non-availability of suitable teaching staff for running a course in the Department.

    b) The facilities for offering the elective papers (courses), sought for by the students are not on offer/scheme in the Institution, but are available on the SWAYAM platform.

    c) The courses offered on SWAYAM would supplement the teaching-learning process in the Institution.

    d) Online courses through SWAYAM should not be more than 20% of total courses offered in a particular semester of a programme.

3. The courses offered in a particular semester will be compiled by Digital India Cell as decided and forwarded by concerned UTDs and affiliated colleges in the prescribed format to digitalindia.ymca@gmail.com and compiled set will be put up in Academic Council for approval.

4. Student can opt for 12-16 weeks course equivalent to 3-6 credits under mentorship of faculty (MHRD MOOC's guidelines 11.1(J) issued by the MHRD vide its orders dated 11/03/2016).

5. Every student being offered a particular paper (course) would be required to register for the MOOCs for that course/paper on SWAYAM through University's/Affiliated College's SWAYAM-NPTEL Local Chapter.

6. The UTD/College may designate a faculty member as course coordinator/mentor to guide the students (at least 20 students) throughout the course with 2 hours per week contribution and with mentor addition on the Local Chapter. The mentor Chairperson/Principal will ensure the provision of facilities for smooth running of the course viz. Internet facility and proper venue in the department/college.

7. Digital India Cell of the University will be the Nodal point for keeping track of MOOCs enrolments in the University and the concerned chairpersons/principals are expected to aware their students/faculty about the online courses.

8. Importance of online learning and credit transfer policy must be shared with the students at entry level by the concerned department/college. Same may be incorporated during induction program for newly admitted students.

9. The departmental/college MOOC coordinators appointed by chairpersons of concerned departments/Principals of affiliated colleges will be responsible for identification of relevant MOOCs in the UTDs/Colleges and smooth conduction during the course.

B. Credit Transfer/Mobility of MOOCs

1. The parent Institution (offering the Course) shall give the equivalent credit weightage to the students for the credits earned through online learning courses through SWAYAM platform in the credit plan of the program.

2. Following pattern will be followed for distribution of credits and will be applicable to all students from Jan 2018 onwards:

Program	Duration	Minimum Credits to be earned*
B.Tech	Semester I to VIII	3
M.Tech/MBA/M.Sc./MA	Semester I to IV	3
BBA/BCA/B.Sc./BA	Semester I to VI	3

***All students of UTDs/Affiliated colleges of all courses have to mandatorily earn minimum prescribed credits. Note: From session 2019-20 onwards, for B.Tech. program, a student has to earn at least 12 credits during the duration of the Degree subject to the passing of at least one MOOC course (carrying minimum 3 credits per year).**

3. A student will be eligible to get Under-Graduate/Post-Graduate degree (B.Tech./M.Tech.) with Honours if he/she completes additional credits through MOOC's. (AICTE Model Curriculum, Chapter1(B)). Following pattern will be followed for earning additional credits for the award of Honours degree:

Program	**Duration**	**Credits to be earned***	**Minimum CGPA**
B.Tech	Semester I to VIII	12	8.0
M.Tech	Semester I to IV	6	8.0

*Inclusive of *Minimum credits to be earned* mentioned in clause B(2) above.

4. The earned credits shall be accepted and transferred to the total credits of the concerned students by the University for Completion of his/her degree. Credits earned through MOOCs will be incorporated in the mark sheet issued to the student by Controller of Examination.

5. Credits for MOOC's will be verified by the concerned department/college and will be forwarded to Controller of Examination for further processing.

6. The courses where model curriculum of AICTE is not applicable, pattern laid down as in B(2) will be followed.

NOTE:

1. These guidelines will be applicable to all Affiliating institutions under University along with all UTDs. Affiliating colleges will establish their own Local Chapter on SWAYAM and follow the same process.

2. For further clarifications, Notifications "Credit Framework for Online Learning Courses through SWAYAM" (UGC Regulations dated 19/07/2016) and "MHRD MOOC's guidelines" (MHRD guidelines dated 11/03/2016) may be referred.

Approved in 17th Academic Council Dated 11.06.2019