## Aniversity of Alumbai



## No. AAMS\_UGS/ICC/2024-25/ 179

#### CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office Circular No. AAMS\_UGS/ICC/2023-24/68 dated  $24^{th}$  November, 2023 relating to the B.E. (Automation and Robotics) (Sem – V & VI) (CBCS).

They are hereby informed that the recommendations made by the Board of Deans at its meeting held on 23<sup>rd</sup> October, 2024 <u>vide</u> item No. 6.7 (N) has been accepted by the Hon'ble Vice Chancellor as per the powers confirmed upon him under Section 12 (7) of the Maharashtra Public Universities Act, 2016 and that in accordance therewith syllabus of **B.E.** (Automation and Robotics) (Sem – VII & VIII) is introduced and the same has been brought into force with effect from the academic year 2024-25.

(The said circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032 30<sup>th</sup> October, 2024

(Dr. Prasad Karande) REGISTRAR

To,

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

#### BOD/6.7(N) /23/10/2024

Copy forwarded with Compliments for information to:-

- 1) The Chairman, Board of Deans,
- 2) The Dean and Associate Dean, Faculty of Science & Technology,
- 3) The Chairman, Board of Studies,
- 4) The Director, Board of Examinations and Evaluation,
- 5) The Director, Department of Students Development,
- 6) The Director, Department of Information & Communication Technology,
- 7) The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari.
- 8) The Deputy Registrar, Admissions, Enrolment, Eligibility & Migration Department (AEM).

Cop	y forwarded for information and necessary action to :-
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), <u>dr@eligi.mu.ac.in</u>
2	The Deputy Registrar, Result unit, Vidyanagari <u>drresults@exam.mu.ac.in</u>
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari <u>cap.exam@mu.ac.in</u>
6	The Deputy Registrar, College Affiliations & Development Department (CAD), <u>deputyregistrar.uni@gmail.com</u>
7	The Deputy Registrar, PRO, Fort, (Publication Section), <u>Pro@mu.ac.in</u>
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in
	He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in <u>ar.tau@fort.mu.ac.in</u>
11	The Deputy Registrar, College Teachers Approval Unit (CTA), <u>concolsection@gmail.com</u>
12	The Deputy Registrars, Finance & Accounts Section, fort <u>draccounts@fort.mu.ac.in</u>
13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
14	The Assistant Registrar, Administrative Sub-Campus Thane, thanesubcampus@mu.ac.in
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentar@gmail.com
17	The Director, Centre for Distance and Online Education (CDOE), Vidyanagari, director@idol.mu.ac.in
18	Director, Innovation, Incubation and Linkages, Dr. Sachin Laddha pinkumanno@gmail.com
19	Director, Department of Lifelong Learning and Extension (DLLE), dlleuniversityofmumbai@gmail.com

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Сор	y for information :-	
1	P.A to Hon'ble Vice-Chancellor,	
	vice-chancellor@mu.ac.in	
2	P.A to Pro-Vice-Chancellor	
	pvc@fort.mu.ac.in	
3	P.A to Registrar,	
-	registrar@fort_mu_ac_in	
4	P.A to all Deans of all Faculties	
5	P.A to Finance & Account Officers, (F & A.O),	
	camu@accounts.mu.ac.in	
	<u></u>	

## To,

1	The Chairman, Board of Deans
	pvc@fort.mu.ac.m
2	Faculty of Humanities,
	Dean •
	1. Prof.Anil Singh
	Dranilsingh129@gmail.com
	Associate Dean
	2. Dr.Suchitra Naik
	Naiksuchitra27@gmail.com
	3.Prof.Manisha Karne
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	3. Prin Kishori Bhagat
	kishoribhagat@rediffmail.com

	Faculty of Science & Technology
	Dean 1. Prof. Shivram Garje <u>ssgarje@chem.mu.ac.in</u>
	Associate Dean
	2. Dr. Madhav R. Rajwade <u>Madhavr64@gmail.com</u>
	3. Prin. Deven Shah sir.deven@gmail.com
	Faculty of Inter-Disciplinary Studies,
	Dean
	1.Dr. Anil K. Singh
	aksingh@trcl.org.in
	Associate Dean
	2.Prin.Chadrashekhar Ashok Chakradeo cachakradeo@gmail.com
3	Chairman, Board of Studies,
4	The Director, Board of Examinations and Evaluation,
	dboee@exam.mu.ac.in
5	The Director, Board of Students Development,
	dsd@mu.ac.in DSW direcotr@dsw.mu.ac.in
6	The Director, Department of Information & Communication Technology,
	director.dict@mu.ac.in

AC – Item No. –



## **University of Mumbai**



Sr. No	Heading	Particulars
1	Title of program O:	B.E. (Automation and Robotics)
2	Eligibility for Admission O:	as per the University Ordinance
3	Standards of Passing R:	40%
4	Semesters	Sem. VII & VIII
5	Program Academic Level	U.G.
6	Pattern	Semester
7	Status	Revised 2019 'C' Scheme
8	To be implemented from Academic Year	2024-25

BoS-Chairman Dr. S. K. Shinde BoS-Chairman-Computer Engineering Faculty of Science & Technology University of Mumbai Offg. Associate Dean Dr. Deven Shah Faculty of Science and Technology University of Mumbai Offg. Dean Prof. Shivram S. Garje Faculty of Science and Technology University of Mumbai

## Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, where in focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the present curriculum skill-based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Final Year of Engineering from the academic year 2024-25. Subsequently this will be carried forward for final year Engineering in the academic years 2024-25 respectively.

# Incorporation and implementation of Online Contents from NPTEL/Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill-based activities and project-based activities. Self-learning opportunities are provided to learners. In this particular syllabus wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. Efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current syllabus based on the recommendation of AICTE model curriculum overall credits are reduced to 170, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. Deven Shah Associate Dean Faculty of Science and Technology University of Mumbai

#### Program Structure for Final Year Automation and Robotics Engineering University of Mumbai (With Effect from 2024-2025) Semester VII

		Teaching Scheme (Contact Hours)			C	
<b>Course Code</b>	Course Name	Theory	Pract.	Theory	Pract	Total
ARC701	Machine Vision System	3	•••	3		3
ARC702	AI for Robots	3	•••	3		3
ARDLO703X	Department Level Optional Course – 3	3	•••	3		3
ARDLO704X	Department Level Optional Course – 4	3	•••	3		3
ILO701X	Institute Level Optional Course – I*	3		3		3
ARL701	Machine Vision system		2		1	1
ARL702	AI for Robots		2		1	1
ARL703	Industrial Skills		2		1	1
ARP701	Major Project -I		6#		3	3
	Total	15	12	15	06	21
				1	1	

		Examination Scheme								
Course Code Course Name			1	Theory	Term	Pract/	Total			
	5	Ir Ass	nternal essment		End	Exam. Duratio	Work	Oral		
		Test 1	Test 2	Avg	Sem. Exam	n (in Hrs)				
ARC701	Machine Vision system	20	20	20	80	3			100	
ARC702	AI for Robots	20	20	20	80	3			100	
ARDLO703X	Department Level Optional Course – 3	20	20	20	80	3			100	
ARDLO704X	Department Level Optional Course – 4	20	20	20	80	3			100	
ILO701X	Institute Level Optional Course – I*	20	20	20	80	3			100	
ARL701	Machine Vision system						25	25	50	
ARL702	AI for Robots						25	25	50	
ARL703	Industrial Skills						25	25	50	
ARP701	Major Project – I						50		50	
Total				100	400		125	75	700	

# indicates work load of Learner & Faculty, for Major project \* Common with all branches

University of Mumbai

Semester	VIII
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Course Code	Course Name	Theory	Pract.	Theory	Pract.	Total
ARC801	Industrial Internet of Things	3		3	C:	3
ARDLO805X	Department Level Optional Course – 5	3		3		3
ARDLO806X	Department Level Optional Course – 6	3		3		3
ILO802X	Institute Level Optional Course – 2*	3		3		3
ARL801	Laboratory based on IoT		2		1	1
ARL802	Product Design and Development		2		1	1
ARP801	Major Project - II		12#		6	6
	Total	12	14	12	8	20

		Examination Scheme										
C				Theor								
Course	Course Name	Interna	Internal Assessment			Exam.	Term	Pract/	<b>T</b> ( )			
Code	Course Name	Test1	Test2	Avg ·	Sem. Exam	Duration (in Hrs)	Work	Oral	Total			
ARC801	Industrial Internet of Things	20	20	20	80	3			100			
ARDLO805X	Department Level Optional Course – 5	20	20	20	80	3			100			
ARDLO806X	Department Level Optional Course – 6	20	20	20	80	3			100			
ILO802X	Institute Level Optional Course – 2*	20	20	20	80	3			100			
ARL801	Laboratory based on IoT						25	25	50			
ARL802	Product Design and Development						25	25	50			
ARP801	Major Project - II						100	50	150			
			80	320	•••	150	100	650				

\$ indicates work load of Learner and Faculty, for Major Project

\* Common with all branches

#### Students group and load of faculty per week.

Major Project 1 and 2:

Students can form groups with minimum 2 (Two) members and not more than 4 (Four) members Faculty Load:

In Semester VII –  $\frac{1}{2}$  hour per week per project group

In Semester VIII – 1 hour per week per project group

## **Department Optional Courses**

Course Code	Sem. VII: Departmental Level optional course -3
ARDLO7031	Mobile Robotics
ARDLO7032	Advanced Computational Techniques
ARDLO7033	Natural Language Processing
ARDLO7034	Internet Communication Engineering

Course Code	Sem. VII: Department Level Optional Course – 4
ARDLO7041	Machinery Diagnostics
ARDLO7042	Big Data Analytics
ARDLO7043	Augmented and Virtual Reality
ARDLO7044	Block chain

Course – 6

Autonomous Vehicle

Total Quality Management

Course Code

ARDLO8061

ARDLO8062

ARDLO8063

Sem. VIII: Department Level Optional

Operation Planning and Control

Course Code	Sem. VIII: Department Level Optional Course – 5
ARDLO8051	Product Design and Development
ARDLO8052	Wireless Networks
ARDLO8053	Micro Electro Mechanical Systems
ARDLO8054	Deep Learning

## **Institute Optional Courses**

Course Code	Institute Optional Course-I#
ILO7011	Product Lifecycle Management
ILO7012	Reliability Engineering
ILO7013	Management Information System
ILO7014	Design of Experiments
ILO7015	Operation Research
ILO7016	Cyber Security and Laws
ILO7017	Disaster Management and Mitigation Measures
ILO7018	Energy Audit and Management
ILO7019	Development Engineering

ARDLO8064	Social Media Analytics
2	
Course Code	Institute Optional Course-II <sup>#</sup>
ILO8021	Project Management
ILO8022	Finance Management
ILO8023	Entrepreneurship Development and Management
ILO8024	Human Resource Management
ILO8025	Professional Ethics and CSR
ILO8026	Research Methodology
ILO8027	IPR and Patenting
ILO8028	Digital Business Management
ILO8029	Environmental Management

# Common with all branches

University of Mumbai

Co	ourse Code	Course Name	Cr	edits
	ARC701	Machine Vision System		03
Co Obje Co Outo	urse 1. 7 ectives 2. 7 3. 7 4. 7 5. 7 urse Stu comes	<ul> <li>Fo understand the need and significance Machine Vision.</li> <li>Fo explore basics of image processing.</li> <li>Fo explore the components of Machine Vision System.</li> <li>Fo develop application using machine Vision.</li> <li>Fo study transformation, interpolation, filters.</li> <li>dents will be able to: <ol> <li>Elaborate the components of Machine Vision Application.</li> <li>Perform image, video pre-processing operations.</li> <li>Explain various transformations, interpolation. Realize the significance processing in automation.</li> <li>Elaborate motion tracking in video.</li> <li>Analyse and Implement appropriate filtering techniques for a give</li> </ol> </li> </ul>	cance of the contract of the c	of digita lem.
Aodule	e	Contents	Hours	CO mappir
ntellige 1.	Introduction Human Eye, C Vision, Compu	s to Machine Vision : Computer and Human Vision Systems, the Computer versus Human Vision Systems, Evolution of Computer ter/Machine Vision and Image Processing, Applications of Computer	04	CO1
	Vision. <b>Digital Image Fundamentals :</b> Digital Image Fundamentals Elements of visual perception, Monochrome and Colour Images, Image Brightness and Contrast., 2D, 3D, and 4D Images, Digital Image Representation, Digital Image File Formats, Fundamental Image Operations, Points, Edges, and Vertices, Point Operations, Thresholding, Brightness, Geometric Transformations, Spatial Transformation, Affine Transformation, Image Interpolation, Nearest-Neighbour Interpolation, Bilinear Interpolation, Bi-cubic Interpolation, Fundamental Steps in Digital Image Processing			
2.	3D, and 4D Ir Fundamental I Thresholding, Affine Transfe Bilinear Interp Processing.	nages, Digital Image Representation, Digital Image File Formats, mage Operations, Points, Edges, and Vertices, Point Operations, Brightness, Geometric Transformations, Spatial Transformation, ormation, Image Interpolation, Nearest-Neighbour Interpolation, plation, Bi-cubic Interpolation, Fundamental Steps in Digital Image	08	CO2

4.	<b>Digital Image Processing for Machine Vision Applications :</b> Pre-processing, Image Filtering, Normalized Box Filter Gaussian Filter Bilateral Filter, Comparison of Filter Techniques, Sub sampling/Scaling Histogram, Image Segmentation, Threshold Based Segmentation Edge-Based Segmentation First-Order Derivative Edge Detection. Second-Order Derivative Operators, Comparison of Edge Detection Techniques, Region-Based Segmentation Region Growing Methods, Region Split and Merge Method, Morphological Image Processing: Dilation, Erosion, Opening, Closing, Hit-or-Miss transformation, Object Recognition. Template Matching. Blob Analysis.	10	CO4
5.	Motion Analysis: Differential motion Analysis, Optical Flow, Analysis based on correspondence of interest points, Detection of specific motion Patterns, Video Tracking.	04	CO5
6.	<b>Emerging Trends in Machine Vision :</b> History of Industrial Revolution(s), Machine Vision and Industry 4.0, Emerging Vision Trends in Manufacturing, 3D Imaging, Emerging Vision Trends in Manufacturing, Applications in Machine/ Computer Vision: Face detection, face recognition, Eigen faces, car on roads.	05	CO6

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

**End Semester Examination:** Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks.
- 2. Question1 will be compulsory and should cover maximum contents of the curriculum
- 3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

## **Reference Books:**

1. Chiranji Lal Chowdhary, Mamoun Alazab, Ankit Chaudhary, Saqib Hakak and Thippa Reddy Gadekallu,

Computer Vision and Recognition Systems Using Machine and Deep Learning Approaches,

Fundamentals, technologies and applications, IET COMPUTING SERIES 42

- 2. Joe Minichino Joseph Howse, learning Open CV
- 3. Computer Vision with Python, Second Edition, Packet Publishing Ltd.
- 4. Alexander Hornberg, Handbook of Machine and Computer Vision the Guide for Developers and Users.

## **Text Books:**

 Sheila Anand and L. Priya, —A Guide for Machine Vision in Quality Control, Taylor & amp; Francis Inc., Imprint CRC Press Inc., Dec 2019.

- 2. Rafael C. Gonzalez and Richard E. Woods, —Digital Image Processing, Pearson
- 3. Carsten Stegar, Markus Ulrich, and Christian Wiedemann , -Machine Vision Algorithms and

University of Mumbai

Applications, Second completely Revised and Enlarged Edition.

 Milan Sonka, Vaclav Hlavac, Roger Boyle, —Image Processing Analysis and Machine Vision, Second Edition, Cengage Learning.

## **Useful Links**

- 1. https://nptel.ac.in/courses/108103174
- 2. https://www.coursera.org/learn/introduction-computer-vision-watson-opencv
- 3. https://www.udacity.com/course/introduction-to-computer-vision--ud810
- 4. <u>https://onlinecourses.nptel.ac.in/noc21\_ee23/preview</u>

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Со	urse Code	Course Name	Cı	redits
A	ARC702	Artificial Intelligence (AI) for Robots		03
Course Objectives       1. To conceptualize the basic ideas and techniques underlying the design systems.         2. To make students understand and explore the mechanism of mind that intelligent thought and action.       3. To make students understand advanced representation formalism and techniques.         4. To make students understand how to deal with uncertain and incompl information.       5. Students will be able to:         Outcomes       1. Ability to develop a basic understanding of AI building bloc intelligent agents.         2. Ability to choose an appropriate problem-solving method representation technique.         3. Ability to design models for reasoning with uncertainty as we unreliable information.         5. Ability to glan and learn Active & amp; Passive reinforcement Le 6. Ability to design and develop AI applications in real world scena		n of inte t enable search ete and k s to kn ell as th arning. rios.	elligent es sented in nowledge owledge— he use of	
Module		Contents	Hours	CO
Drorogy	isita: Disorata	Mathematics Data Structures		mapping
1.	Introduction Introduction, I of Intelligent S AI, Applicatio	to Artificial Intelligence Listory of Artificial Intelligence, Intelligent Systems: Categorization System, Components of AI Program, Foundations of AI, Sub-areas of ns of AI, Current trends in AI.	04	CO1
2.	Intelligent Ag Agents and Er The structure of Solving proble Example Prob	ents avironments, The concept of rationality, The nature of environment, of Agents, Types of Agents, Learning Agent. em by Searching: Problem Solving Agent, Formulating Problems, lems.	04	CO2
3.	Problem solvi Uninformed So Depth Limited Methods: Gree Local Search Simulated ann Adversarial S	ng earch Methods: Breadth First Search (BFS), Depth First Search (DFS), I Search, Depth First Iterative Deepening (DFID), Informed Search edy best first Search, A* Search, Memory bounded heuristic Search. Algorithms and Optimization Problems: Hill climbing search ealing, Genetic algorithms. earch: Game Playing, Min-Max Search, Alpha Beta Pruning	10	CO3

4.	Knowledge and Reasoning Knowledge based Agents, Brief Overview of propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining. Knowledge Engineering in First-Order Logic, Unification, Resolution. Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Simple Inference in belief network.	12	CO4
5.	Planning and Learning The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning. Learning: Forms of Learning, Theory of Learning, PAC learning. Introduction to statistical learning (Introduction only) Introduction to reinforcement learning: Learning from Rewards, Passive Reinforcement Learning, Active reinforcement Learning	05	CO5
6.	AI Applications A. Introduction to NLP- Language models, Grammars, Parsing B. Robotics - Robots, Robot hardware, Problems Robotics can solve C. AI applications in Healthcare, Retail, Banking	04	CO6

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

**End Semester Examination:** Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks.
- 2. Question1 will be compulsory and should cover maximum contents of the curriculum
- 3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

#### **Textbooks:**

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth

Edition" Pearson Education, 2020.

- 2. Saroj Kaushik, "Artificial Intelligence", Cengage Learning, First edition, 2011
- 3. George F Luger, "Artificial Intelligence" Low Price Edition, Fourth edition, Pearson Education., 2005

## **References:**

- 1. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
- 2. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
- 3. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
- 4. Elaine Rich and Kevin Knight, "Artificial Intelligence", Third Edition, McGraw Hill Education, 2017.

Course Code		Course Name	Cre	edits
AR	DL07031	Mobile Robotics	03	
Course Object	e 1. tives 2. 3. 4.	Familiarize with essential elements of robotic locomotion. Comprehend challenges in realizing robotic locomotion. Familiarize with the concepts of path planning and navigation. Impart knowledge on the basics of robot learning and collective rol	botics.	
Course	e Stude	nt will be able to:		
Outcon	1. 2. 3. 4. 5. 6.	Understand the fundamental principles of mobile robotics. Design, analyze, and implement efficient and agile robotic systems Enable effective perception, sensing, localization, and mapping f mobile robot navigation. Designing and implementing efficient robotic systems capable localization, navigation, and coordination in diverse environments. Apply design of feedback control system. Comprehensive understanding of Advance Mobile Robotics.	or auto	nomol
ſodule		Contents	Hours	CO mappi
<b>Prerequ</b> . Know . Unde . Famil	<b>uisite:</b> vledge of robotic rstanding of prog liarity with linear	s fundamentals, including kinematics, dynamics, and control systems gramming languages like Python, C++, or MATLAB. r algebra, calculus, and probability theory.	5.	
1.	Introduction to and application mobile robots: constraints in m	Mobile Robotics: Overview of Mobile Robotics: Definition, scope, s, Historical perspective and evolution of mobile robots, Types of Wheeled, tracked, legged, aerial, underwater, Challenges and obile robotics: Power, mobility, sensing, control.	06	CO1
1. 2.	Introduction to and application mobile robots: constraints in m Kinematics &a and inverse kin motion, Dynam stability analysi	<ul> <li>Mobile Robotics: Overview of Mobile Robotics: Definition, scope, s, Historical perspective and evolution of mobile robots, Types of Wheeled, tracked, legged, aerial, underwater, Challenges and obile robotics: Power, mobility, sensing, control.</li> <li>mp; Dynamics of Mobile Robots: Kinematic modelling: Forward nematics for mobile platforms, Differential drive and holonomic tics of mobile robots: Newton- Euler equations, motion control, s, Trajectory planning and obstacle avoidance algorithms.</li> </ul>	06 06	CO1 CO2
1.         2.         3.	Introduction to and application mobile robots: constraints in m Kinematics &a and inverse kin motion, Dynam stability analysi Perception and Cameras, LIDA Kalman filterin (SLAM) algorit	<ul> <li>Mobile Robotics: Overview of Mobile Robotics: Definition, scope, s, Historical perspective and evolution of mobile robots, Types of Wheeled, tracked, legged, aerial, underwater, Challenges and obile robotics: Power, mobility, sensing, control.</li> <li>mp; Dynamics of Mobile Robots: Kinematic modelling: Forward nematics for mobile platforms, Differential drive and holonomic tics of mobile robots: Newton- Euler equations, motion control, s, Trajectory planning and obstacle avoidance algorithms.</li> <li>Sensing for Mobile Robots: Sensor technologies for mobile robots: R, ultrasonic sensors, IMUs, encoders, Sensor fusion techniques: g, Bayesian methods, Simultaneous Localization and Mapping hms, Environmental modelling and mapping techniques.</li> </ul>	06 06 07	CO1 CO2 CO3

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5.	<b>Control Systems for Mobile Robots :</b> Control architectures for mobile robots: Behaviour-based, hierarchical, and hybrid systems, Feedback control design for motion and trajectory tracking, PID control and its application in mobile robotics, Model Predictive Control (MPC) and its relevance in mobile robot control	07	CO5
6.	Advanced Topics in Mobile Robotics: Swarm robotics and collective behaviours in mobile robot teams, Human-robot interaction and social robotics, Autonomous systems and artificial intelligence in mobile robots, Ethical considerations and societal impact of mobile robotics.	06	CO6

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

#### **Theory Examination:**

- 1. Question paper will comprise of 6 questions, each carrying 20 Marks.
- 2. Total 4 questions need to be solved.
- 3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of

4 to 5 marks will be asked.

4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

#### **Reference Books:**

- 1. "Introduction to Autonomous Mobile Robots" by Roland Siegwart, Illah R. Nourbakhsh, and Davide Scaramuzza.
- 2. "Probabilistic Robotics" by Sebastian Thrun, Wolfram Burgard, and Dieter Fox.
- 3. "Robotics: Modelling, Planning, and Control" by Bruno Siciliano and Lorenzo Sciavicco.
- 4. "Mobile Robotics: Mathematics, Models, and Methods" by Alonzo Kelly and Vladimir Sukhoy.
- 5. "Mobile Robots: Navigation, Control, and Remote Sensing" by Gerald Cook.
- 6. "Modern Robotics: Mechanics, Planning, and Control" by Kevin M. Lynch and Frank C. Park.
- 7. "Robotics: Everything You Need to Know About Robotics from Beginner to Expert" by Peter Mckinnon.

Co	urse Code	Course Name	Cr	edits
AR	DL07032	Advanced Computational Techniques		03
Course	e Objectives	<ol> <li>To introduce advanced computational techniques applicable and Robotics</li> <li>To develop skills in numerical methods for problem-solving automation</li> <li>To enable students to implement algorithms and models for and machine learning applications</li> </ol>	to Au in rob control	tomation otics and systems
Course	e Outcomes	Student will be able to:		
		<ol> <li>Implement numerical methods to analyze and optimize control</li> <li>Analyze and manipulate signals or functions in both continued domains.</li> <li>Effectively solve boundary value problems and analyze eigen in mathematical and computational contexts.</li> <li>Apply methods to solve parabolic and hyperbolic part equations.</li> <li>Analyze complex physical phenomena in various scientific a applications.</li> <li>Effectively optimize robotic systems, improving their pe efficiency across various applications.</li> </ol>	ol syste ous and value e tial dif and eng erforma	ms I discrete equations fferential gineering unce and
Module		Contents	Hours	CO mapping
Prerequ	<b>iisite:</b> .1. Know 2. Under 3. Famili	ledge of basic programming languages (e.g., Python, C++, MATLAB) standing of calculus, linear algebra, and differential equations arity with basic algorithms and data structures.	)	
	Numerical M			
1.	system, Newto for convergence	ethods for Control Systems: Fixed point iteration for a non-linear on Raphson method for solving system of non-linear equations, criteria e, error analysis.	06	CO1
1. 2.	system, Newto for convergence Fourier appr Fourier series, Fourier transfo	ethods for Control Systems: Fixed point iteration for a non-linear on Raphson method for solving system of non-linear equations, criteria e, error analysis. oximations: Curve fitting with sinusoidal functions, Continuous Fourier integral and transforms, Discrete Fourier transforms, Fast rms	06	CO1 CO2

4.	<b>Solution of partial differential equations-I:</b> Finite difference methods: Parabolic: Forward time central space & amp; Crank Nicolson method Hyperbolic: Lax- Friedrichs method & amp; Mac Cormack method Finite volume methods: Monotonic upstream-cantered (MUSCL), Riemann Solver	07	CO4
5.	Solution of partial differential equations-II: Finite element methods: hp-FEM, Discontinuous Galerkin (DG) Meshfree Methods: Smoothed-particle hydrodynamics, Moving particle semi-implicit method.	07	CO5
6.	<b>Optimization Techniques in Robotics:</b> Gradient-based and metaheuristic optimization algorithms: Sequential quadratic programming, Genetic algorithms, simulated annealing.	06	CO6

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

#### **Theory Examination:**

- 1. Question paper will comprise of 6 questions, each carrying 20 Marks.
- 2. Total 4 questions need to be solved.
- 3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of

4 to 5 marks will be asked.

4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

## **Text Books:**

- 1. "Numerical solutions for Differential Equations" by Smith G.D, Mc Graw Hill
- 2. "Modern Methods for Engineering Computations" by Ketter and Prawel, Mc Graw Hill
- 3. "Numerical Methods for Initial and Boundary value problems," by Rajasekharan S. Khanna publishers 2003.
- 4. "Optimization Theory and applications" by S.S. Rao, Wiley Eastern
- 5. "Numerical Methods for Engineers" by Steven C. Chapra and Raymond P. Canale
- 6. "Optimization Techniques in Engineering" by G. S. R. Murthy

## **Reference Books:**

- 1. "Numerical Optimization" by Jorge Nocedal and Stephen J. Wright
- 2. "Pattern Recognition and Machine Learning" by Christopher M. Bishop
- 3. "Introduction to Autonomous Robots" by Nikolaus Correll and Michael A. Goodrich
- 4. "Control Systems Engineering" by Norman S. Nise
- 5. "Introduction to Robotics: Mechanics and Control" by John J. Craig

ARDL07033         Natural Language Processing           Course Objectives: The course aims         .           1. To define natural language processing and to learn various stages language processing.         2.           2. To describe basic concepts and algorithmic description of the ma levels: Morphology, Syntax, Semantics, and Pragmatics & Discourse a           3. To design and implement various language models and POS tagging te           4. To design and learn NLP applications such as Information Extractic answering.           5. To design and implement applications based on natural language proce           Course Outcomes: Students will be able           1. To design language model for word level analysis for text processing.           2. To design language model for word level analysis for text processing.           3. To design various POS tagging techniques and parsers.           4. To design, implement and test algorithms for semantic and pragmatic           5. To formulate the discourse segmentation and anaphora resolution.           6. To apply NLP techniques to design real world NLP applications.           7.           Module         Contents           Prerequisite: Theory of Computer Science, System Programming & Compiler Construction           Introduction to NLP: Origin & History of NLP; Language, Knowledge and Grammar in language processing; Stages in NLP; Ambiguities and its types in English and Indian Regional Languages; Challenges of NLP; Applications of NLP and the functionalities	Course Name		se Code Course Name	Course Name C		Credits
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Module       Contents       Hours         Prerequisite: Theory of Computer Science, System Programming & Compiler Construction       Introduction to NLP: Origin & History of NLP; Language, Knowledge and Grammar in language processing; Stages in NLP; Ambiguities and its types in English and Indian Regional Languages; Challenges of NLP; Applications of NLP       03         1.       Self-Learning topics: Variety types of tools for regional languages pre-processing and other functionalities       03         Word Level Analysis : Basic Terms: Tokenization, Stemming, Lemmatization; Survey of English Morphology, Inflectional Morphology, Derivational Morphology; Regular expression with types; Morphological Models: Dictionary lookup, finite state morphology; Morphological parsing with EST (Einite State Transducer): Lexicon free EST Porter Stemmer						
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closed vocabulary tasks; Evaluating N-grams: Perplexity; Smoothing: Laplace	asks; Evaluating N-9	Perplexity: Smoothing: Laplace	<u>,</u>			

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	Self-Learning topics: Noisy channel models, various edit distance, Advance Issues in Language Modelling		
	<b>Syntax analysis :</b> Part-Of-Speech tagging(POS); Tag set for English (Upenn Treebank); Difficulties /Challenges in POS tagging; Rule-based, Stochastic and Transformation-based tagging; Generative Model: Hidden Markov Model (HMM Viterbi) for POS tagging;	2	
3.	Issues in HMM POS tagging; Discriminative Model: Maximum Entropy model, Conditional random Field (CRF);Parsers: Top down and Bottom up; Modelling constituency; Bottom Up Parser: CYK, PCFG (Probabilistic Context Free Grammar), Shift Reduce Parser; Top Down Parser: Early Parser, Predictive Parser	10	CO3
	Self-Learning topics: Evaluating parsers, Parsers based language modelling, Regional languages POS tree banks		
4.	<ul> <li>Semantic Analysis : Introduction, meaning representation; Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet, Babelnet; Relations among lexemes &amp; their senses –Homonymy, Polysemy, Synonymy, Hyponymy; Semantic Ambiguity; Word Sense Disambiguation (WSD); Knowledge based approach( Lesk's Algorithm), Supervised (Naïve Bayes, Decision List),Introduction to Semi-supervised method (Yarowsky) Unsupervised (Hyperlex)</li> <li>Self-Learning topics: Dictionaries for regional languages, Distributional Semantics Topic Models</li> </ul>	07	CO4
5.	Pragmatic & Discourse Processing : Discourse: Reference Resolution, Reference         Phenomena, Syntactic & Semantic constraint on coherence; Anaphora Resolution         using Hobbs and Cantering Algorithm         Self Learning August Discourse Discourse Conference methods	05	CO5
	Self-Learning topics: Discourse segmentation, Conference resolution Applications of NLP: Case studies on (preferable in regional language) Machine		
6.	translation; Text Summarization; Sentiment analysis; Information retrieval; Question Answering system	05	CO6
	<b>Self-Learning topics:</b> Applications based on Deep Neural Network with NLP such as LSTM network, Recurrent Neural network etc.		

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

## **Theory Examination:**

- 1. Question paper will comprise of 6 questions, each carrying 20 Marks.
- 2. Total 4 questions need to be solved.
- 3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of
- 4 to 5 marks will be asked.
- 4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

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#### **Text Books:**

- 1. Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
- 2. Christopher D.Manning and HinrichSchutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.

#### **Reference Books:**

- 1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
- 2. Daniel M Bikel and ImedZitouni Multilingual natural language processing applications: from theory to practice, IBM Press, 2013.
- 3. Alexander Clark, Chris Fox, Shalom Lappin The Handbook of Computational Linguistics and Natural Language Processing, John Wiley and Sons, 2012.
- 4. Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.
- 5. Niel J le Roux and SugnetLubbe, A step by step tutorial: An introduction into R application and programming.
- 6. Steven Bird, Ewan Klein and Edward Loper, Natural language processing with Python: analyzing text with the natural language toolkit, O\_Reilly Media, 2009.

## **Useful Links:**

- 1. http://www.cse.iitb.ac.in/~cs626-449
- 2. http://cse24-iiith.virtual-labs.ac.in/#
- 3. https://nptel.ac.in/courses/106105158

Cou	ırse Code	Course Name	Cre	edits
ARDLO7034		Internet Communication Engineering	(	03
<ul> <li>Course Objectives         <ol> <li>To focus on Internet protocol, standards, services and admi</li> <li>To discuss the Internet security protocol and security servic</li> <li>To discuss multimedia communication standards and techniques</li> <li>To add insights on software defined network &amp; amp; netwo</li> <li>To introduce Internet of Things</li> </ol> </li> <li>Course Outcomes         <ol> <li>After successful completion of the course student will be able to:                 <ol> <li>Explain the protocols at each layer of TCP/IP protocol suite.</li> <li>Explain the internet security aspects of protocols at various laye protocol suite.</li> <li>Apply the various compression algorithms for audio, image &amp; v</li> <li>Design simple networked multimedia systems.</li> <li>Evaluate integrated &amp; differentiated services for quality of services for generative services for generative</li></ol></li></ol></li></ul>				
		6. Explain a software defined Network.		
	1		TT	CO
/Iodule		Contents	Hours	mappin
/Iodule Prerequ	i <b>site:</b> Analog c Networks	Contents communication, Digital Communication and Computer Communication	on and	mappir
/lodule Prerequ	i <b>isite:</b> Analog c Networks Introduction t description, Ne	Contents communication, Digital Communication and Computer Communication s to Internet: What is the Internet, Evolution of the Internet, service etwork protocol? Overview of TCP/IP, layer functions	on and	mappir CO1
/lodule Prerequ 1. 2.	isite: Analog c Networks Introduction t description, Ne Application La Domain Name HTTPS, electro	Contents communication, Digital Communication and Computer Communications to Internet: What is the Internet, Evolution of the Internet, service twork protocol? Overview of TCP/IP, layer functions ayer in the Internet : Application Layer- Host configuration, DHCP, System (DNS), Multicast DNS, Remote Login, TELNET and SSH, onic mail	03 06	mappir CO1 CO2
Iodule         rerequination         1.         2.         3.	isite: Analog c Networks Introduction t description, Ne Application La Domain Name HTTPS, electro Internet Secur (SSL), Applica Intrusion Detec	Contents communication, Digital Communication and Computer Communications to Internet: What is the Internet, Evolution of the Internet, service etwork protocol? Overview of TCP/IP, layer functions ayer in the Internet : Application Layer- Host configuration, DHCP, System (DNS), Multicast DNS, Remote Login, TELNET and SSH, onic mail ity: Network layer security (AH, ESP, IPsec) Transport layer security tion layer security (secure E mail- PGP, S/MIME), VPN Firewall, ction System.	01 and 03 06 05 05	CO1 CO2 CO3
Iodule         rerequ         1.         2.         3.         4.	isite: Analog c Networks Introduction t description, Ne Application La Domain Name HTTPS, electro Internet Secur (SSL), Applica Intrusion Detec Multimedia Co video, Text and standards: H.26 speech, image a Multimedia tran RTCP, DVMRI IPTV	Contents communication, Digital Communication and Computer Communications to Internet: What is the Internet, Evolution of the Internet, service etwork protocol? Overview of TCP/IP, layer functions ayer in the Internet : Application Layer- Host configuration, DHCP, System (DNS), Multicast DNS, Remote Login, TELNET and SSH, onic mail ity: Network layer security (AH, ESP, IPsec) Transport layer security tion layer security (secure E mail- PGP, S/MIME), VPN Firewall, ction System. ommunications: Information Representation- text, images, audio and d image compression, Audio and video compression. compression 51, H.263, P1.323, MPEG 1, MPEG 2, Other coding formats for text, and video nsport across IP networks and relevant protocols such as RSVP, RTP, P, Signalling Protocols: Real-Time Streaming Protocol (RTSP). VoIP,	Hours on and 03 06 05 10	<u>таррі</u> СО1 СО2 СО3 СО4

Network Industry Trends & Automation:

Introduction to software defined networking, OPENFLOW, Why network automation? Simplified Architectures, Deterministic outcomes, Business Agility, Types of network automation, Device Provisioning, Data collection, Migrations,

6. Configuration Management, Compliance, Reporting, Troubleshooting, Evolving from the management plane from SNMP to device APIs--- Impact of open networking, Network Automation in the SDN era.

Introduction to Internet of Things (IoT): Definition and characteristics of IoT, Physical design of IoT: Things in IoT, IoT Protocols.

#### **Internal Assessment:**

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

## **Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.

- 2. Total 4 questions need to be solved.
- 3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of

4 to 5 marks will be asked.

4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

## **Text Books:**

- **1.** B. Forouzan, —TCP/IP Protocol Suitel, 4th Edition, McGraw-Hill Publication
- **2.** K. R. Rao, Zaron S. Bojkovic, Dragorad A. Milocanovic, Multimedia Communication Systems, Prentice Hall India, 2002. ISBN: 81-203-2145-6.
- 3. Network Programmability & amp; Automation---Jason Edelman, Scott S. Lowe & Matt Oswalt, OREILLY.

## **Reference Books:**

- 1. Steve Heath, Multimedia and Communication Technology, Second Edition, Focal Press, 2003.
- 2. ISBN: 81-8147-145-8. Ted Wallingford, —Switching to VoIP, Oreilly Publication
- 3. Fred Halsall, —Multimedia Communications, Pearson education, 2001
- 4. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, —Multimedia Communication Systems, Pearson education, 2004.
- 5. Raif steinmetz, Klara Nahrstedt, —Multimedia: Computing, Communications and Applications, Pearson education, 2002.
- 6. Tay Vaughan, —Multimedia: Making it Workl, 6th edition, Tata McGraw Hill, 2004
- 7. Pallapa Venkataram, —Multimedia information systems<sup>II</sup>, Pearson education (InPress), 2005.
- 8. Multimedia Communication Techniques and Standards
- 9. Arshdeep Bagha, Vijay Madisetti "Internet of Things", universities Press.

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B. E. (Automation & Robotics)

**CO6** 

08

Cou	urse Code	Course Name	Credit	
ARDLO7041		Machinery Diagnostics		03
Course	e Objectives	<ol> <li>To study basic concepts of Vibration Monitoring</li> <li>To study different Vibration Measuring Instruments</li> <li>To study fault detection in Machines using vibration spectrum</li> </ol>	ctrum	•
Course	e Outcomes	Student will be able to:		
		1. Relate basic concepts of Machinery Diagnostic.		
		2. Describe the working of Vibration Measuring Instrument	ts.	
		<ol> <li>Apply different Signal Processing Techniques in Vibratio Measurement.</li> </ol>	on	
		4. Identify common faults in Machinery using Vibration Sp	ectrum	l <b>.</b>
		5. Interpret the Vibration Signals for Monitoring and Progn	osis.	
				СО
Module		Contents	Hours	mappir
1.	Basics of Vibra RMS, Peak and analysis, Phase speed in accurat Introduction to	<ul> <li>ation : Periodic and random motion, Spectral Amplitude Scaling: Peakto-Peak Conversion and Selection, Time and frequency domain analysis, Orbit analysis, Understanding signal pattern, Importance of the diagnosis, Importance of side bands in frequency spectrums.</li> <li>Vibration based Condition Monitoring: Maintenance Principles, fault Programs Cool of Vibration Monitoring. Stars in Vibration</li> </ul>	07	CO1
	Monitoring, Ber	nefits of Vibration based condition monitoring. Steps in vibration		
2.	Vibration Meas acceleration; Fo Sensor Selection	surement : Vibration measuring instruments: displacement, velocity, orce measurement, Laser based measurements: laser vibrometer of Criteria, Sensor – Mounting Locations and Techniques	07	CO2
3.	<b>Data Acquisitio</b> Fast Fourier Tra Formats, Freque Averages, Wind	on & Signal Processing : Classification of signals, Signal analysis, ansform (FFT), Essential Settings in Data Acquisition System (Plot ency Span and Frequency Resolution, Average Types and Number of lowing, Spectrum Scaling), Signal conditioning	07	CO3
4.	Machinery Fau approach), Time Misalignment, S	<b>ult Diagnosis I :</b> Natural frequency and resonance tests (Practical e and Frequency domain analysis to identify unbalance, bent shaft, soft foot conditions, Mechanical looseness	06	CO4
5.	Machinery Fau diagnosis, Fault	<b>It Diagnosis II</b> : Rolling element bearing and Journal Bearing fault ts related to Gearbox, vane defects in pumps, Fault in Fans and	06	CO4

	Applications of Condition Monitoring: Case studies related Balancing Problems		
	in Turbines, Condition Monitoring in Sugar mills, Health Monitoring of Journal		CO5
6.	Bearing, Condition Monitoring of Industrial Pumps. (Aspects to be covered :	06	005
	Selection of sensors, recommended location of sensor, direction of measurement,		
	selection of plot type, Data validation and Identification of Faults)		

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

#### **Theory Examination:**

- 1. Question paper will comprise of 6 questions, each carrying 20 Marks.
- 2. Total 4 questions need to be solved.
- 3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of
- 4 to 5 marks will be asked.
- 4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

#### **Reference / Text Books:**

- 1. R.B. Randall, "Vibration-based Condition Monitoring", Wiley2021, ISBN: 978-1-119-47755-6
- 2. A.R. Mohanty, "Machine Condition Monitoring: Principles and Practices", CRC Press 2017, ISBN: 9781138748255
- 3. R.A. Collacott, "Mechanical Fault Diagnosis and Condition Monitoring",1st Edition, Chapman and Hall, ISBN: 978-94-009-5723-7
- 4. J.S. Rao, "Vibratory Condition Monitoring of Machine", Narosa Publishing House.

#### **Useful Links:**

https://nptel.ac.in/courses/112105232 – Machinery Fault Diagnosis and Signal Processing, IIT, Kharagpur.

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Cou	urse Code	Course Name	C	redits	
AR	DL07042	Big Data Analytics		03	
Course	<ol> <li>Course Objectives         <ol> <li>To provide an overview of the big data platforms, its use c ecosystem.</li> <li>To introduce programming skills to build simple solution technologies such as MapReduce, Scripting for No SQL is analytics with scalability and streaming capability.</li> <li>To enable students to have skills that will help them to sol world problems for decision support.</li> </ol> </li> </ol>				
	-	1. Understand the building blocks of Big Data Analytics.			
		<ol> <li>Apply fundamental enabling techniques like Hadoop and solving real world.</li> </ol>	d Mapl	Reduce in	
		3. Understand different NoSQL systems and how it handles	big da	ta.	
		4. Apply advanced techniques for emerging application analytics.	ons lik	te stream	
		5. Achieve adequate perspectives of big data analytics in var like recommender systems, social media applications, etc	ious ap	plications	
		6. Apply statistical computing techniques and graphics for data.	or anal	yzing big	
Madula		Contents	Uouro	СО	
Moune		Contents	HUUI 5	mapping	
Prerequ	iisite: Database,	, Data mining.			
	Introduction t	o Big Data and Hadoop			
4	Introduction to	Big Data - Big Data characteristics and Types of Big Data			
1.	Traditional vs.	Big Data business approach	02	CO1	
	Case Study of H	Big Data Solutions			
	Concept of Had	loop, Core Hadoop Components; Hadoop Ecosystem			
	Hadoop HDFS	and MapReduce			
	Distributed File File-System Or	e Systems: Physical Organization of Compute Nodes, Large- Scale ganization.			
2.	MapReduce: T Details of Mapl Algorithms Us	he Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Reduce Execution, Coping With Node Failures. sing MapReduce: Matrix-Vector Multiplication by MapReduce,	08	CO2	

	Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Hadoop Limitations.		
3.	NoSQL Introduction to NoSQL, NoSQL Business Drivers. NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study. NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems.	10	CO3
4.	Mining Data StreamsThe Stream Data Model: A Data-Stream-Management System, Examples of StreamSources, Stream Queries, Issues in Stream Processing.Sampling Data techniques in a Stream.Filtering Streams: Bloom Filter with Analysis.Counting Distinct Elements in a Stream, Count- Distinct Problem,Flajolet-Martin Algorithm, Combining Estimates, Space Requirements.Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm,Decaying Windows.	11	CO4
5.	Real-Time Big Data Models         A Model for Recommendation Systems, Content-Based Recommendations,         Collaborative Filtering.         Case Study: Product Recommendation         Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery         of Communities in a social graph	04	CO5
6.	Data Analytics with R Exploring Basic features of R, Exploring RGUI, Exploring RStudio, Handling Basic Expressions in R, Variables in R, Working with Vectors, Storing and Calculating Values in R, Creating and using Objects, Interacting with users, Handling data in R workspace, Executing Scripts, Creating Plots, Accessing help and documentation in R. Reading datasets and Exporting data from R, Manipulating and Processing Data in R, Using functions instead of script, built-in functions in R. Data Visualization: Types, Applications	04	CO6

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

#### **Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.

2. Total 4 questions need to be solved.

3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.

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4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

#### **Text Books:**

- 1. Cre Anand Rajaraman and Jeff Ullman Mining of Massive Datasets, Cambridge University Press
- 2. Alex Holmes Hadoop in Practicel, Manning Press, Dreamtech Press.
- 3. Dan Mcary and Ann Kelly —Making Sense of NoSQLI A guide for managers and the rest of us, Manning Press.
- 4. DT Editorial Services, "Big Data Black Book", Dreamtech Press
- 5. EMC Education Services, "Data Science and Big Data Analytics", Wiley

#### **Reference Books:**

- 1. Bill Franks, —Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics, Wiley.
- 2. Chuck Lam, —Hadoop in Action, Dreamtech Press
- 3. Jared Dean, —Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners, Wiley India Private Limited, 2014.
- 4. Jiawei Han and Micheline Kamber, —Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 3rd ed, 2010.
- 5. Lior Rokach and Oded Maimon, —Data Mining and Knowledge Discovery Handbook, Springer, 2nd edition, 2010.
- 6. Ronen Feldman and James Sanger, —The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Datal, Cambridge University Press, 2006.
- 7. Vojislav Kecman, —Learning and Soft Computing, MIT Press, 2010.

## **Useful Links:**

- 1. https://nptel.ac.in/courses/106104189
- 2. https://www.coursera.org/specializations/big-data#courses
- 3. https://www.digimat.in/nptel/courses/video/106106169/L01.html
- 4. https://www.coursera.org/learn/nosql-databases#syllabus
- 5. https://www.coursera.org/learn/basic-recommender-systems#syllabus

<b></b>					
Co	urse Code	Course Name	C	redits	
AR	DL07043	Augmented and Virtual Reality	03		
Course	<ul> <li>Course Objectives         <ol> <li>To learn the underlying concepts of Augmented and Virtu primitives of computer graphics.</li> <li>To understand the use of hardware devices in AR-VR syst</li> <li>To understand the tracking system in AR.</li> <li>To apply concept of calibration and registration of different in AR system</li> <li>To design AR-VR applications.</li> <li>To understand the use of AR-VR in interdisciplina applications</li> </ol> </li> <li>Course Outcomes         <ol> <li>Identify and compare different Virtual and Augmented to the tracking and provide the tot.</li> <li>Identify and use AR-VR hardware components.</li> <li>Apply concepts of Computer Vision for tracking in AR System</li> </ol> </li> </ul>			rtual Reality and ystem. rent components nary immersive mented Reality Systems.	
Module		<ul> <li>5. Design AR-VR application</li> <li>6. Apply insights of AR-VR in different applications.</li> </ul>	Hours	CO	
Prerequ	i <b>isite:</b> Programm	ing Language, Computer Graphics		mapping	
1.	Introduction to Definition and S Architecture, Ch Augmented Rea Applications). U Geometric Mod View Transforr ubiquitous comp	Augmented and Virtual Reality Scope, A Brief History of Augmented and Virtual Reality, AR-VR hallenges with AR-VR, AR-VR systems and functionality, Types of ality Application (Location Based AR Apps Marker-Based AR Understanding Virtual Space and Geometry: coordinate systems, elling, 2D transformations, 3D rotation and 6 degree of freedom, nation, projective transformation, Related fields: MR, XR and buting and their comparison.	05	CO1	
2.	Visual Physiolo Mechanics of S fundamentals, o Visual Perceptio audio displays. A	<b>by</b> , <b>perception and Interaction</b> Sight: the visual pathway, spatial vision and depth cues. Display optical architecture. Augmenting displays. Multimodal Displays; on; Spatial Display Model; Visual Displays. Mechanics of hearing, Augmented and Virtual reality Hardware.	05	CO2	
3.	<b>Tracking and C</b> Characteristics Sensors; Optica Natural feature t	Computer Vision for AR of Tracking Technology; Stationary Tracking Systems; Mobile al Tracking; Sensor Fusion; Marker Tracking, infrared tracking, tracking by detection.	10	CO3	

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4.	Calibrations and Registration Camera projection and setup for AR. Camera calibration techniques. Registration	06	CO4
5.	AR-VR Application Development AR-VR Application Requirements, Software engineering requirements, AR-VR Design Principles, Data Flow, Scene Graphs; Developer Support: Parameter Configuration, Tools used in AR-VR development.	07	CO5
6.	Applications of AR-VR and Human Factors, Legal and Social Considerations Applications of AR-VR in: Edutainment, Medical, Military, Production and Manufacturing, Navigation, Astronomical Observation, E-commerce; What are Human Factors, Physical Side Effects, Visual Side Effects, Legal Considerations, Moral and Ethical Considerations	06	CO6

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

#### **Theory Examination:**

- 1. Question paper will comprise of 6 questions, each carrying 20 Marks.
- 2. Total 4 questions need to be solved.
- 3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
- 4. Remaining questions will be mixed in nature.
- 5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

#### **Text Books:**

- 1. John Vince, "Virtual Reality Systems", Pearson publication
- 2. Tony Parisi, "Learning Virtual Reality", O'REILLY'
- 3. Dieter Schmalsteig and Tobias Hollerer, "Augmented Reality- Principles and Practice", Pearson Education, Inc. 2016 Edition.
- 4. Chetankumar G Shetty, "Augmented Reality- Theory, Design and Development", Mc Graw Hill, 2020 Edition.
- 5. Alan B. Craig, "Understanding Augmented Reality Concepts and Applications", Morgan Kaufmann, Elsevier, 2013 Edition.

## **References Books:**

- 1. Borko Furht, "Handbook of Augmented Reality", Springer.
- 2. Erin Pangilinan, Steve Lukas, and Vasanth Mohan, "Creating Augmented and Virtual Realities Theory and Practice for Next-Generation Spatial Computing", O'Reilly Media, Inc., 2019 Edition.
- 3. Jens Grubert, Dr. Raphael Grasset, "Augmented Reality for Android Application Development", PACKT Publishing.

#### Useful Links:

- 1. www.nptel.ac.in
- 2. www.coursera.org

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Cou	urse Code	Course Name	Cr	edits
ARDL07044Block ChainCourse Objectives1. Understand blockchain platforms and its terminologies. 2. Understand the use of cryptography required for blockch 3. Understand smart contracts, wallets, and consensus prote 4. Design and develop blockchain applicationsCourse OutcomesStudent will be able to:		Block Chain	03	
		<ol> <li>Understand blockchain platforms and its terminologies.</li> <li>Understand the use of cryptography required for blockchain.</li> <li>Understand smart contracts, wallets, and consensus protocols.</li> <li>Design and develop blockchain applications</li> <li>Student will be able to:</li> </ol>		
		<ol> <li>Explain blockchain concepts.</li> <li>Apply cryptographic hash required for blockchain.</li> <li>Apply the concepts of smart contracts for an application.</li> <li>Design a public blockchain using Ethereum.</li> <li>Design a private blockchain using Hyperledger.</li> <li>Use different types of tools for blockchain applications.</li> </ol>		
Module		Contents	Hours	CO mappin
Prerequ	isite: Cryptog	raphy and System Security		
2.	<b>Introduction</b> What is a block Foundation of Components Consortium, C	to Blockchain kchain, Origin of blockchain (cryptographically secure hash functions), blockchain: Merkle trees. of blockchain, Block in blockchain, Types: Public, Private, and Consensus Protocol, Limitations and Challenges of blockchain	06	CO1
2.	Cryptocurren Cryptocurren in Blockchain Bitcoin block (PoB), Proof- Mining diffic	ency: Bitcoin, Altcoin, and Tokens (Utility and Security), cy wallets: Hot and cold wallets, Cryptocurrency usage, Transactions n, UTXO and double spending problem. kchain: Consensus in Bitcoin, Proof-of-Work (PoW), Proof-of-Burn of-Stake (PoS), and Proof-of-Elapsed Time (PoET), Life of a miner, culty, Mining pool and its methods	06	CO2
3.	<b>Programmir</b> Introduction Contract, Sm Introduction and Activity Fixed and Dy Inheritance	<b>ig for Blockchain</b> to Smart Contracts, Types of Smart Contracts, Structure of a Smart hart Contract Approaches, Limitations of Smart Contracts. to Programming: Solidity Programming – Basics, functions, Visibility Qualifiers, Address and Address Payable, Bytes and Enums, Arrays- ynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Error handling.	08	CO3
	Case Study	- Voting Contract App, Preparing for smart contract development		

	and Ethereum Types of test-networks used in Ethereum Transferring Ethers using Metamask		
	Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum		
	blockchain. Exploring etherscan.io and ether block structure		
5.	<ul> <li>Private Blockchain</li> <li>Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain - PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT.</li> <li>Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric &amp; Other Technologies.</li> <li>Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes, Transaction Flow, Working of Hyperledger Fabric, Creating Hyperledger Network, Case Study of Supply Chain Management using Hyperledger.</li> </ul>	08	CO5
6.	<b>Tools and Applications of Blockchain</b> Corda, Ripple, Quorum and other Emerging Blockchain Platforms, Blockchain in DeFi: Case Study on any of the Blockchain Platforms.	03	CO6

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

#### **Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.

2. Total 4 questions need to be solved.

3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.

4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

#### **Text Books:**

- **1.** Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and Meena Karthikeyen, Universities Press.
- 2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
- 3. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing

#### **Reference Books:**

- 1. Blockchain for Beginners, Yathish R and Tejaswini N, SPD.
- 2. Blockchain Basics, A non-Technical Introduction in 25 Steps, Daniel Drescher, A press.
- 3. Blockchain with Hyperledger Fabric, Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing

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## **Useful Links:**

- 1. Blockchain By Example, Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, November 2018, Implement decentralized blockchain applications to build scalable Dapps.
- 2. Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7.
- 3. https://www.hyperledger.org/use/fabric
- 4. NPTEL: https://onlinecourses.nptel.ac.in/noc19\_cs63/preview

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## **Course Name**

03

ILO7011

**Product Life Cycle Management** 

#### **Objectives:**

- 1. To familiarize the students with the need, benefits and components of PLM
- 2. To acquaint students with Product Data Management & PLM strategies
- 3. To give insights into new product development programs and guidelines for designing and developinga product
- 4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to...

- 1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- 2. Illustrate various approaches and techniques for designing and developing products.
- 3. Apply product engineering guidelines/thumb rules in designing products for moulding, machining, sheet metal working etc.
- 4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Sr. No.	Contents	Hrs
01	Introduction to Product Lifecycle Management (PLM):Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities ofGlobalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits ofPLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM	10
02	<b>Product Design:</b> Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies ofDesign Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and VariantManagement, The Design for X System, Objective Properties and Design for X. Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	<b>Product Data Management (PDM):</b> Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDMsystem, financial justification of PDM, barriers to PDM implementation	05
04	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques,	05
Jniversi	ty of Mumbai B. E. (Automation & Re	obotic
	Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
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05	<b>Integration of Environmental Aspects in Product Design:</b> Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

### **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

### **References:**

- John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
- 2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
- 3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
- Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

<b>Course Code</b>	Course Name	Credits
ILO7012	Reliability Engineering	03

- 1. To familiarize the students with various aspects of probability theory
- 2. To acquaint the students with reliability and its concepts
- 3. To introduce the students to methods of estimating the system reliability of simple and complex systems
- 4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to...

- 1. Understand and apply the concept of Probability to engineering problems
- 2. Apply various reliability concepts to calculate different reliability parameters
- 3. Estimate the system reliability of simple and complex systems
- 4. Carry out a Failure Mode Effect and Criticality Analysis

Sr. No.	Detailed Contents	Hrs
1	<ul> <li>Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.</li> <li>Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.</li> <li>Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.</li> </ul>	08
2	<ul> <li>Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.</li> <li>Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time to Failure (MTTF), MTBF, Reliability Functions.</li> <li>Reliability Hazard Models: Constant Failure Rate, linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.</li> </ul>	08
3	<b>System Reliability:</b> System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
4	<b>Reliability Improvement:</b> Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, SuccessPath method, Decomposition method.	08
5	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
6	<b>Failure Mode, Effects and Criticality Analysis:</b> Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

#### **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

#### **References:**

- 1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
- 2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
- 3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
- 4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
- 5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
- 6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	Management Information System	03

- 1. The course is blend of Management and Technical field.
- 2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- 3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- 4. Identify the basic steps in systems development

Outcomes: Learner will be able to...

- 1. Explain how information systems Transform Business
- 2. Identify the impact information systems have on an organization
- 3. Describe IT infrastructure and its components and its current trends
- 4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- 5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Sr. No.	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	04
02	Data and Knowledge Management: Database Approach, Big Data, Datawarehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysisand Presenting Results	07
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	07
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	07
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	06
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System developmentlife cycle models.	08

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- 4. Only Four questions need to be solved.

### **References:**

- 1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
- 2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10<sup>th</sup> Ed., Prentice Hall, 2007.
- 3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 20

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Course Code	Course Name	Credits
ILO7014	Design of Experiments	03

- 1. To understand the issues and principles of Design of Experiments (DOE).
- 2. To list the guidelines for designing experiments.
- 3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization.

**Outcomes:** Learner will be able to...

- 1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action.
- 2. Apply the methods taught to real life situations.
- 3. Plan, analyze, and interpret the results of experiments.

Sr. No	Detailed Contents	Hrs
	Introduction	
	1.1 Strategy of Experimentation	
01	1.2 Typical Applications of Experimental Design	06
	1.3 Guidelines for Designing Experiments	
	1.4 Response Surface Methodology	
	Fitting Regression Models	
	2.1 Linear Regression Models	
	2.2 Estimation of the Parameters in Linear Regression Models	
03	2.3 Hypothesis Testing in Multiple Regression	08
02	2.4 Confidence Intervals in Multiple Regression	
	2.5 Prediction of new response observation	
	2.6 Regression model diagnostics	
	2.7 Testing for lack of fit	
	Two-Leve <mark>l Factorial Designs</mark>	
	3.1 The $2^2$ Design	
	3.2 The 2 <sup>3</sup> Design	
03	3.3 The General2 <sup>k</sup> Design	07
03	3.4 A Single Replicate of the 2 <sup>k</sup> Design	
	3.5 The Addition of Center Points to the $2^k$ Design,	
	3.6 Blocking in the 2 <sup>k</sup> Factorial Design	
	3.7 Split-Plot Designs	
	Two-Level Fractional Factorial Designs	
04	4.1 The One-Half Fraction of the 2 <sup>k</sup> Design	07
04	4.2 The One-Ouarter Fraction of the $2^k$ Design	
U-T	12 The one Quarter Haction of the 2 Design	

	4.4 Resolution III Designs	
	4.5 Resolution IV and V Designs	
	4.6 Fractional Factorial Split-Plot Designs	
	Response Surface Methods and Designs	
	5.1 Introduction to Response Surface Methodology	
05	5.2 The Method of Steepest Ascent	07
	5.3 Analysis of a Second-Order Response Surface	
	5.4 Experimental Designs for Fitting Response Surfaces	·
-	Taguchi Approach	
06	6.1 Crossed Array Designs and Signal-to-Noise Ratios	04
50	6.2 Analysis Methods	
	0.5 Kobust design examples	

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- 4. Only Four questions need to be solved.

### **References:**

- Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3<sup>rd</sup> edition, John Wiley & Sons, New York, 2001
- 2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
- George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2<sup>nd</sup> Ed. Wiley
- W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc.ISBN: 0-471-39054-2
- Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Vos

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Course Code	Course Name	Credits
ILO7015	<b>Operations Research</b>	03

- 1. Formulate a real-world problem as a mathematical programming model.
- 2. Understand the mathematical tools that are needed to solve optimization problems.
- 3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to...

- 1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- 2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- 3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- 4. Understand the applications of integer programming and a queuing model and compute important performance measures

Sr. No.	Detailed Contents	Hrs
01	Introduction to Operations Research: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines andm Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	<b>Queuing models</b> : queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05

03	Simulation: Introduction, Methodology of Simulation, Basic Concepts, SimulationProcedure, Application of Simulation Monte-Carlo Method: Introduction,Monte-Carlo Simulation, Applications of Simulation,Advantages of Simulation, Limitations of Simulation	05
04	<b>Dynamic programming</b> . Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

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### 4. Only Four questions need to be solved.

### **References:**

- 1. Taha, H.A. "Operations Research An Introduction", Prentice Hall, (7th Edition), 2002.
- 2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
- 3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
- 4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
- 5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & S

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Course Code	Course Name	Credits
ILO7016	Cyber Security and Laws	03

- 1. To understand and identify different types cybercrime and cyber law
- 2. To recognized Indian IT Act 2008 and its latest amendments
- 3. To learn various types of security standards compliances

Outcomes: Learner will be able to...

- 1. Understand the concept of cybercrime and its effect on outside world
- 2. Interpret and apply IT law in various legal issues
- 3. Distinguish different aspects of cyber law
- 4. Apply Information Security Standards compliance during software design and development

Sr. No.	Detailed Contents	Hrs
	Introduction to Cybercrime: Cybercrime definition and origins of the world,	
0.1	Cybercrime and information security, Classifications of cybercrime, Cybercrime and	
01	the Indian ITA 2000, A global Perspective on cybercrimes.	04
	Cyber offenses & Cybercrime: How criminal plan the attacks, Social Engg, Cyber	
	stalking, Cybercafe and Cybercrimes, Botnets, Attack vector, Cloud computing,	
	Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds	
	in Mobile and Wireless Computing Era, Security Challenges Posed by MobileDevices,	
	Registry Settings for Mobile Devices, Authentication Service Security, Attacks on	
02	Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations,	09
	Organizational Measures for Handling Mobile, Devices-Related Security Issues,	
	Organizational Security Policies and Measures in Mobile Computing Era, Laptops	
	Tools and Methods Used in Cyberline	
	Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms,	
03	Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow,	06
	Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	
	The Concept of Cyberspace	
	E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of cyber	
	Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in	
04	Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law,	08
	Legal Framework for Electronic Data Interchange Law Relating to Electronic	
	Banking , The Need for an Indian CyberLaw	

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	Indian IT Act.	
05	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under The IT	06
	Act, 2000, IT Act. 2008 and its Amendments	
06	Information Security Standard compliances	06
00	SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	00

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#### **End Semester Examination:**

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- 4. Only Four questions need to be solved.

#### **References:**

- 1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
- 2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
- 3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
- 4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
- 5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
- 6. Kennetch J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.
- 7. William Stallings, Cryptography and Network Security, Pearson Publication
- 8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
- Website for more information , A Compliance Primer for IT professional https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-3353

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B. E. (Automation & Robotics)

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Course Code	Course Name	Credits
ILO7017	Disaster Management and MitigationMeasures	03

- 1. To understand physics and various types of disaster occurring around the world
- 2. To identify extent and damaging capacity of a disaster
- 3. To study and understand the means of losses and methods to overcome /minimize it.
- 4. To understand role of individual and various organization during and after disaster
- 5. To understand application of GIS in the field of disaster management
- 6. To understand the emergency government response structures before, during and after disaster

### **Outcomes: Learner will be able to...**

- 1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- 2. Plan of national importance structures based upon the previous history.
- 3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- 4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Sr. No.	Detailed Contents	Hrs
	Introduction	
01	1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective,	03
	importance of study in human life, Direct and indirect effects of disasters, long term	
	effects of disasters. Introduction to global warmingand climate change.	
	Natural Disaster and Manmade disasters:	
	2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flashflood,	
	drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions,	
02	Mudflow, Cyclone, Storm, Storm Surge, climatechange, global warming, sea	09
	level rise, ozone depletion	
	2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of	
	growing population and subsequent industrialization, urbanization and changing	
	lifestyle of human beings in frequent occurrences of manmade disasters.	

03	<ul> <li>Disaster Management, Policy and Administration</li> <li>3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.</li> <li>3.2 Policy and administration: Importance and principles of disaster management policies, command and coordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.</li> </ul>	06
04	<ul> <li>Institutional Framework for Disaster Management in India:</li> <li>4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.</li> <li>4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.</li> </ul>	06
05	<ul> <li>Financing Relief Measures:</li> <li>5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as wellas overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways toapproach these teams.</li> <li>5.2 International relief aid agencies and their role in extreme events.</li> </ul>	09
06	<ul> <li>Preventive and Mitigation Measures:</li> <li>6.1 Pre-disaster, during disaster and post-disaster measures in some events ingeneral</li> <li>6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication</li> <li>6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awarenessand education, contingency plans.</li> <li>6.4 Do's and don'ts in case of disasters and effective implementation of reliefaids.</li> </ul>	06

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#### **References:**

- 1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
- 2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
- 3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
- 4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
- 5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
- 6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation R B Singh, Rawat Publications
- 7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites.

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Course Code	Course Name	Credits
ILO7018	Energy Audit and Management	03

- 1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- 2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- 3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

### **Outcomes: Learner will be able to...**

- 1. To identify and describe present state of energy security and its importance.
- 2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- 3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- 4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- 5. To analyze the data collected during performance evaluation and recommend energy saving measures

Sr. No	Detailed Contents	Hrs
01	<b>Energy Scenario:</b> Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	Energy Audit Principles: 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, Optimizingthe input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis.Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	<b>Energy Management and Energy Conservation in Electrical System:</b> Electricity billing, Electrical load management and maximum demand Control;Power factor improvement, Energy efficient equipment's and appliances, starratings. <b>Energy efficiency measures in lighting system, Lighting control:</b> Occupancy sensors, daylight integration, and use of intelligent controllers.	10

	Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	<ul> <li>Energy Management and Energy Conservation in Thermal Systems: Review of different thermal loads; Energy conservation opportunities in: Steamdistribution system, Assessment of steam distribution losses, Steam leakages,Steam trapping, Condensate and flash steam recovery system.</li> <li>General fuel economy measures in Boilers and furnaces, Waste heat recovery, useof insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.</li> </ul>	10
05	<b>Energy Performance Assessment:</b> On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

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### **References:**

- 1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
- 2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
- 3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
- 4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
- 5. Energy Management Principles, C.B.Smith, Pergamon Press
- 6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
- 7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
- 8. www.energymanagertraining.com
- 9. www.bee-india.nic.in

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Course Code	Course Name	Credits
ILO7019	Development Engineering	03

- 1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
- 2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
- 3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
- 4. To understand the Nature and Type of Human Values relevant to Planning Institutions

**Outcomes:** Learner will be able to...

- 1. Apply knowledge for Rural Development.
- 2. Apply knowledge for Management Issues.
- 3. Apply knowledge for Initiatives and Strategies
- 4. Develop acumen for higher education and research.
- 5. Master the art of working in group of different nature.
- 6. Develop confidence to take up rural project activities independently

Sr. No.	Detailed Contents	Hrs
01	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
02	Post-Independence rural Development Balwant Rai Mehta Committee -three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	04
03	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	06

04	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes inrural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
05	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planningprofession, research and education. Types of Values Psychological values — integrated personality; mentalhealth; Societal values — the modern search for a good society; justice,democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral andethical values; nature of moral judgment; Spiritual values; differentconcepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; humanvalues as freedom, creativity, love and wisdom.	10
06	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

# End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

# 4. Only Four questions need to be solved

### **References:**

- 1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
- 2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
- 3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
- 4. Planning Commission, Five Year Plans, Planning Commission

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- Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
- 6. Planning Guide to Beginners
- 7. Weaver, R.C., The Urban Complex, Doubleday.
- 8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
- 9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
- 10. Watson, V., Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 407

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Lab Code	Lab Name	Credits
ARL701	Machine Vision System Lab	1

#### Prerequisite: Computer Graphics, Image Processing, Python

### Lab Objectives:

- 1. To perform basic image processing operations.
- 2. To explore different pre-processing technique.
- 3. To develop application related to Machine vision.
- 4. To detect and recognize objects.

### Lab Outcomes:

- 1. Students will be able to read image and video file, perform different processing.
- 2. Students will be able to do edge detection, depth estimation.
- 3. Students will be able to choose appropriate algo for segmentation.
- 4. Students will be able to implement object detection technique.

Suggested Experiments:

Students are required to complete at least 8 experiments.

Sr.	
No.	Name of the Experiment
	Handling Files, Cameras, and GUIs Basic I/O scripts, Reading/writing an image file, converting between an image and raw bytes,
1	Accessing image data with numpy. array, Reading/writing a video file, Capturing camera frames,
	Displaying images in a window, Displaying camera frames in a window.
2	Processing Images with Open CV3
2	Converting between different colour spaces, The Fourier Transform, High pass filter, Low pass filter
	Edge detection with Canny
3	Contour detection, Contours – bounding box, minimum area rectangle, and minimum enclosing
	circle, Contours – convex contours and the Douglas-Peucker algorithm, Line and circle detection
	Depth Estimation
4	Capturing frames from a depth camera Creating a mask from a disparity map Masking a copy
	operation Depth estimation with a normal camera
5	Object segmentation using the Watershed and GrabCut algorithms, Example of foreground
3	detection with GrabCut, Image segmentation with the Watershed algorithm

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	Detecting and Recognizing Faces
6	Conceptualizing Haar cascades
	Getting Haar cascade data
	Using OpenCV to perform face detection
	Performing face detection on a still image
	Performing face detection on video
	Performing face recognition
7	Generating the data for face recognition Recognizing faces
/	Preparing the training data
	Loading the data and recognizing faces
	Performing an Eigenfaces recognition
	Retrieving Images and Searching
	Using Image Descriptors,
0	Feature detection algorithms,
8	Defining features Detecting features – corners
	Feature extraction and description using DoG and SIFT
	Anatomy of a key point
	Detecting and Recognizing Objects
	Object detection and recognition techniques
	HOG descriptors
0	The scale issue
9	The location issue
	Non-maximum (or non-maxima) suppression
	Support vector machines
	People detection
	Creating and training an object detector
	Bag-of-words
10	BOW in computer vision
	Detecting cars in a scene

### Term Work:

- 1. Term work should consist of 8 experiments.
- 2. Journal must include at least 2 assignments.
- 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

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4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05marks)

### **Practical Oral Examination:**

Oral examination will be based on entire syllabus.

### **Reference & Useful Links:**

- Learning OpenCV 3 Computer Vision with Python Second Edition, by Joe Minichino Joseph Howse Published by Packt Publishing Ltd.
- 2. http://iitk.ac.in/ee/computer-vision-lab
- 3. https://nptel.ac.in/courses/108103174
- 4. https://docs.opencv.org/3.4/d9/df8/tutorial\_root.html

Lab C	Code Lab Name	Credit
ARL	702 Artificial Intelligence for Robot Lab	1
Prerequis	site: Discrete Mathematics, Data Structure	
Lab Obje	ectives:	
	1 To realize the basic techniques to build intelligent syster	ms
	2 To apply appropriate search techniques used in problem	solving
	3 To create knowledge base for uncertain data	
Lab Outo	comes: At the end of the course, the students will be able to	
	1 Identify languages and technologies for Artificial Intellig	gence
	<sup>2</sup> Understand and implement uninformed and informed world problems.	searching techniques for rea
	3 Create a knowledge base using any AI language.	
	4 Design and implement expert systems for real world pro	oblems.
Sugges	sted List of Experiments (programming in python)	
Sr. No.	Title of Experiment	
1	One case study on AI applications published in IEEE/ACM/Springer of journal.	or any prominent
2 a	Assignments on State space formulation and PEAS representation applications	for various AI
3	Program on uninformed search methods.	
4	Program on informed search methods.	
5 F	Program on Game playing algorithms.	
6	Program for first order Logic	
7	Planning Programming	
8	Implementation for Bayes Belief Network	
Note: A	Any other practical covering the syllabus topics and subtopics can be c	conducted.

# Term Work:

- 1 Term work should consist of a minimum of 8 experiments.
- 2 Journal must include at least 2 assignments on content of theory and practical of "Artificial Intelligence"
- 3 The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

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4 Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Oral & Practical exam: Based on the entire syllabus of Artificial Intelligence for Robot

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ARL703	Industrial Skills	01
Course Code	Course Name	Credits

**Course Rationale**: This course has been designed to prepare final year mechanical engineering students for placements, as well as to build computer skills and advanced soft skills to make them ready for a careerin the industry.

### **Objectives**:

- 1. To familiarise mechanical engineering students with basic computer/IT skills in the industry.
- 2. To practise soft skills and communication to be industry-ready.
- 3. To inculcate critical thinking and problem-solving abilities for efficient team and project outcomes.
- 4. To be prepared for campus placements by practising aptitude, logical reasoning, Group discussionand personal interview rounds.

# Outcomes: At the end of the course, the learners will be able to

- 1. Skilfully prepare and edit documents and slides on MS Word and MS PowerPoint etc.
- 2. Execute functions on MS Excel.
- 3. Learn how to navigate tasks and execute functions in G-suite.
- 4. Understand and practice metacognitive skills of creativity and problem solving.
- 5. Hone team building and leadership skills,

Perform well in campus placement rounds by practising Aptitude, Logical reasoning, Group Discussion and Personal Interviews

Module	List of Experiments and Activities	No. of Lab sessions (*2hrs)
1	Computer/IT skills	6
1.1 1.2	Basics of Computers- Desktop/Laptop operations Microsoft Office	
1.2.1	• MS Word- Assignment to Create and use various commandsin a Word document (Page setup, text formatting, templates, SmartArt, Title and Ribbon bar, Editing etc.)	
1.2.2	• <b>MS Excel</b> - Assignment to Create and tabulate a spreadsheet(Excel- data analysis, charts, pivot tables, VBA, etc.)	
1.2.3	• <b>MS- Power point</b> - Assignment to design and use a Presentation Software (MSPPT, Prezi, etc. – Presentation	

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1.2.4	<ul> <li>design, templates, custom slides, animation, graphs, charts, troubleshooting etc.)</li> <li>MS Outlook (Navigation, archiving, tasks distribution, filters, scheduling etc.)</li> </ul>	
1.3	• G-Suite (Gmail, G-Meet, Calendar, Sheets, Docs, Slides etc.)	
1.4	• An introduction to the typesetting package LATEX.	
2	Aptitude and Logical Reasoning	2
2.1 2.2	Aptitude – Aptitude training, types of questions, mock tests Logical Reasoning – Verbal and Non-verbal reasoning, Types of questions, Mock tests	
3	Developing Metacognitive skills	2
1		
3.1	Task orientation and Goal setting (can be based on Final yearProject):	
3.1 3.2	Task orientation and Goal setting (can be based on Final yearProject): Creativity and Problem-solving	
3.1 3.2 <b>4</b>	Task orientation and Goal setting (can be based on Final yearProject):         Creativity and Problem-solving         Collaborative Techniques:Team building skills	1
3.1 3.2 4 4.1	Task orientation and Goal setting (can be based on Final yearProject): Creativity and Problem-solving Collaborative Techniques:Team building skills Activities on Team building	1
3.1 3.2 4 4.1 4.2	Task orientation and Goal setting (can be based on Final yearProject):         Creativity and Problem-solving         Collaborative Techniques:Team building skills         Activities on Team building         Case studies on Leadership, Decision making and Team building	1
3.1 3.2 4 4.1 4.2 5	Task orientation and Goal setting (can be based on Final yearProject):         Creativity and Problem-solving         Collaborative Techniques: Team building skills         Activities on Team building         Case studies on Leadership, Decision making and Team building         GD – PI	1

Assignments: Assignments and activities should enable a steady progress in developing the afore mentioned

skills. A record of the conducted activities can be attached in journal as image printouts, and write up of case studies.

- 1. Application of MS Office skills (Individual)
  - Create and edit Word documents
  - Create and execute MS Excel functions
  - Create and enhance MS PPT
- 2. Writing a simple document in LATEX editor and running the typesetter program to produce finished document
- 3. Aptitude and Logical reasoning tests/practice sheets
- 4. Team building skills: Activities/Tasks to be performed as a team of 3 or 4 students.
- 5. Group Discussions

Case studies on problem-solving to be done as a team activity.

Personal Interview questions log book

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#### Assessment: Total – 50 Marks

Marks distribution will be as follows:

#### FINAL TERM WORK - 25 Marks

Assignments (Journal) - 20

Marks Attendance - 05 Marks

### **ORALS/Written – 25 Marks**

#### 1. Aptitude Test (Written) - 15 Marks

#### 2. Mock Interview (Orals) – 10 Marks

#### **Books recommended/References/ Resources:**

- 1. Meenakshi Raman, Prakash Singh. *Business Communication*, Oxford University Press, 2012
- 2. Claudyne Wilder. The Presentations Kit: 10 steps for Selling Your Ideas, John Wiley & Sons, 1994.
- 3. Lesikar, Flatley. *Basic Business Communication*: Skills for Empowering the Internet Generation, Tata McGraw Hill, 2008.
- 4. Flavell, J. H. *Cognitive development*: Past, present, and future. 1992.
- 5. Thorpe, Edgar and Showick Thorpe. *Objective English*, Pearson, 2013. (7<sup>th</sup>edition Amazon)
- 6. Thorpe, Edgar. *Test of Reasoning*: for All Competitive Examination. 7<sup>th</sup> edition., Amazon
- 7. Sinha, Nishit K., Reasoning, Pearson.
- 8. Aggarwal, R.S., *A Modern Approach to Logical Reasoning*, S. Chand.
- 9. Weblinks https://cambridge-community.org.uk/professional-development/gswmeta/index.html
- 10. Various Quantitative aptitude books and websites listhttps://eduly.in/best-quantitativeaptitude-books/

https://prepinsta.com/learn-aptitude/

https://www.simplilearn.com/learn-ms-excel-free-training-course-skillup

### NPTEL

Creativityhttps://nptel.ac.in/courses/109101017

#### **Course Era**

MS Excelhttps://www.coursera.org/projects/introduction-microsoft-excel G-suite

https://www.coursera.org/projects/collaborating-g-suite-apps Problem solving

https://www.coursera.org/learn/problem-solving Udemy G-suite

https://www.udemy.com/course/learn-gsuite

Course Code	Course Name	Credits
ARP701	Major Project 1	03

**Objectives:** The course aims:

The Project work facilitates the students to develop and prove Technical, Professional and Ethicalskills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.

	Outcomes:
1	Students will be able to develop the understanding of the problem domain through extensive review of literature.
2	Students will be able to identify and analyze the problem in detail to define its scope withproblem specific data.
3	Students will be able to identify various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4	Students will be able to design solutions for real-time problems that will positively impactsociety and environment.
5	Students will be able to develop clarity of presentation based on communication, teamwork and leadership skills.
6	Students will be able to inculcate professional and ethical behavior.

# **Guidelines:**

### **1. Project Topic Selection and Allocation:**

- Project topic selection Process to be defined and followed:
  - Project orientation can be given at the end of sixth semester.
  - Students should be informed about the domain and domain experts whose guidance can betaken before selecting projects.
  - Student's should be recommended to refer papers from reputed conferences/ journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
  - Students can certainly take ideas from anywhere, but be sure that they should evolve themin the unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.

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- Topics can be finalized with respect to following criterion:
- **Topic Selection**: The topics selected should be novel in nature (Product based, Applicationbased or Research based) or should work towards removing the lacuna in currently existing systems
- Technology Used: Use of latest technology or modern tools can be encouraged.
  - Students should not repeat work done previously (work done in the last three years).
- Project work must be carried out by the group of at least 2 students and maximum 4.
- The project work can be undertaken in a research institute or organization/Industry/any businessestablishment. (out-house projects)
- The project proposal presentations can be scheduled according to the domains and should be judgedby faculty who are expert in the domain.
- Head of department and senior staff along with project coordinators will take decision regardingfinal selection of projects.
- Guide allocation should be done and students have to submit weekly progress report to the internalguide.
- Internal guide has to keep track of the progress of the project and also has to maintain attendancereport. This progress report can be used for awarding term work marks.
- In case of industry/ out-house projects, visit by internal guide will be preferred and externalmembers can be called during the presentation at various levels

# 2. Project Report Format:

At the end of semester, each group need to prepare a project report as per the guidelines issued by the University of Mumbai.

A project report should preferably contain at least following details:

- > Abstract
- Introduction
- Literature Survey
- Survey of Existing systems
- Limitations of Existing systems or research gaps
- Motivation (Challenges that are encouraging to choose the problem)
- Problem Statement and Proposed Solution
- Scope of the system
- Proposed System
  - General Workflow/Block diagram
- Analysis and Modeling (only applicable diagrams)
- Design
  - Architectural View
  - Algorithms/ Methodology
- Experimental Set up
  - Details of Database or details about input to systemsor selected data
  - Performance Evaluation Parameters (for Validation)
  - Software and Hardware Set up
- Implementation Plan for Next Semester
  - Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
- Summary
- References

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### Desirable

• Students can be asked to undergo some Certification course (for the technical skill set that will be useful and applicable for projects.)

# 3 Term Work:

Distribution of marks for term work shall be done based on following:

a. Weekly Log Report

**b.** Project Work Contribution

c. Project Report (Spiral Bound) (both side print)

**a.** Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

# 4 Term work evaluation:

Term work evaluation for Project 1 should be conducted by Internal examiner on continuous basis

throughout the semester.

# Suggested quality evaluation parameters are as follows:

- **1.** Quality of problem selected
- 2. Clarity of problem definition and feasibility of problem solution
- 3. Relevance to the specialization / industrial trends
- 4. Originality
- 5. Clarity of objective and scope
- 6. Quality of analysis and design
- 7. Quality of written and oral presentation
- 1. Individual as well as team work

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<b>Course Code</b>	Course Name	Credits
ARC801	Industrial Internet of Things	03

**Prerequisites:** Systems in Mechanical Engineering, Programming and Problem Solving, Basic Electronics Engineering, Solid Mechanics, Solid Modeling and Drafting, Electrical and Electronics Engineering, Mechatronics, Measurement Laboratory, Fluid Power & Control Laboratory

### **Course Objectives:**

- 1. Introduction to IoT, Overview of IoT Building Blocks
- 2. Build small applications in IoT for Mechanical Engineering Applications using Sensors, Actuators, Microcontrollers and Cloud
- 3. Learn commonly used IoT Simulation Hardware platforms
- 4. Understand different Communication Technologies used in IoT
- 5. Development of application-level protocol and Security of IoT Ecosystem
- 6. Understand IoT applications in different domains

### **Course Outcomes:**

On completion of the course the learner will be able to;

- 1. EXPLAIN the Applications/Devices, Protocols and Communication Models of IoT
- 2. DEMONSTARTE small Mechanical Engineering IoT oriented applications using Sensors, Actuators, Microcontrollers and Cloud
- 3. SELECT commonly used IoT Simulation Hardware platforms
- 4. APPLICATION of Interfacing and Communication Technologies for IoT.
- 5. ILLUSTRATE IoT Application Development and Security of IoT Ecosystem
- 6. EVALUATE Present and Future Domain specific Applications of IoT Ecosystem

Module	Details	Hrs	CO mapping
	Overview, History, Definition and Characteristics, Connectivity		
	Terminologies, Building blocks, Types of technologies used in IoT		
	System, Baseline Technologies (Machine-to-Machine (M2M)		
	communications, Cyber-Physical-Systems (CPS)), IoT Vs M2M, IoT		
	enabled Technologies, IoT Levels and Templates, Design Methodology,		
	The Physical Design Vs Logical Design of IoT, Functional blocks of IoT		
01	and Communication Models/Technologies, Development Tools used in	07	CO1
	IoT, IoT Architecture and Protocols, Various Platforms for IoT,		COI
	Real time Examples of IoT,		
· · · · ·	Challenges in IoT, The process flow of an IoT application, Evolution		
	of Connected Devices, Applications of IoT, IoT Enablers, Overview of		
	Governance, Privacy and Security Issues.		
	Measuring physical and virtual quantities in digital world, Overview		
	of Sensors working, Analog Vs Digital Sensors, Wired Vs Wireless		
02	Sensors, Types of Sensors, Types of Converters	07	CO2
	Types of Transducers and Actuator, Controlling Hardware, Types		

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	of Controllor Dolo of microscretrollor of externor to interfacing		
	of Controller, Role of Inicrocontroller Vs Microprocessor Type of		
	microcontrollers in embedded System		
	IoT supported Hardware platforms. Introduction to IoT		
	Simulation Environment and Devices (Raspherry Pi Espressif		
	Processors Arduino) Architecture Setup IDE Installation		
	Interfaces (serial SPI I2C) Programming with focus on interfacing		
	for reading input from ping connecting external		
	tor reading input from pins, connecting external		
	gadgets/sensors/actuators, Controlling and Displaying Output,		
0.2	Libraries, Basics of Embedded C programming	07	
03	Interfacing: Interfacing Input Intermediate Output and Display	07	CO3
	Sensors Converters Actuators Controlling Hardware Controllers		
	and Network Devices		
	<b>IoT Architecture:</b> Building architecture and Open-source		
	architecture (OIC), Main design principles and needed capabilities,		
	An IoT architecture outline, Standards Considerations		
	Communication: Overview and Working of Controlled Systems,		
	Connectivity models - TCP/IP Vs OSI model, IoT Communication		
	Models, IoT Communication APIs, Serial Vs Parallel		
	Communication, Wires Vs Wireless Communication, their		
	Technologies and Hardware		
	<b>IoT Communication Protocols:</b> Protocol Standardization for IoT.		
	Role of M2M in IoT, M2M Value Chains, IoT Value Chains, M2M		
04	and WSN Protocols (SCADA and RFID)	07	
04		07	CO4
	Physical Servers and Cloud Platforms: Web server, Posting		004
	sensor(s) data to web server, Introduction to Cloud Storage models		
	and Communication APIs Webserver, API Virtualizationconcepts		
	and Cloud Architecture, Advantages and limitations of Cloud		
	computing, IoT Cloud platforms, Cloud services enabled devices,		
	IoT devices Security for consumer devices, Security levels, protecting		
	Application Protocols. MOTT REST/HTTP SOI Back-and		
	Application Designing (Designing with Apache MySOI HTMI		
	CSS) Non SOL Back-end Application Designing (MongoDR		
05	Object Type Database, iQuery for UI Designing (MoligoDD	05	
	processing		005
	Security: Need of security in IoT. Security & Privacy during		CO5
	development, Privacy for IoT		

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06	<ul> <li>IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms/middleware, Business, Manufacturing, Smart Homes/Home automation, Surveillance applications, Connected Vehicles, Agriculture, Healthcare, Activity Monitoring, Retail, Logistics, Security, Health and Lifestyle, Legal challenges, IoT in Environmental Protection Modern Day IoT Applications, Smart Grid, Smart Cities - Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities</li> <li>Future: Future IoT ecosystem, Need of powerful core for building secure algorithms, Examples for new trends (AI, ML penetration to IoT)</li> </ul>	07	CO6
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**Text Books:** 

- 1. Bahga, A. and Madisetti, V., (2015), "Internet of Things A Hands-on Approach," Universities Press, ISBN: 9788173719547
- 2. Hajjaj, S S H. and Gsangaya, K. R., (2022), "The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers," CRC Press, ISBN: 9781032110950
- 3. Raj, P. and Raman, A. C., (2017), "The Internet of Things: Enabling Technologies, Platforms, and Use Cases," Auerbach Publications/CRC Press, ISBN: 9781498761284
- 4. Adrian McEwen, A. and Cassimally, H., (2013), "Designing the Internet of Things," John Wiley and Sons, ISBN:
- 5. Veneri, G., Capasso, A., (2018), "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0," Packt Publishing, ISBN: 9781789537222
- 6. Hersent, O, Boswarthick, D., Elloumi, O., (2012), "The Internet of Things: Key Applications and Protocols", Wiley, ISBN: 9781119994350
- 7. Uckelmann, D., Harrison, M., Michahelles, F., (2011), "Architecting the Internet of Things," Springer, ISBN: 9781119994350

#### **References Books:**

- 1. daCosta, F., (2013), "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications, ISBN: 9781430257417
- 2. Waher, P., (2015), "Learning Internet of Things," Packt Publishing, ISBN: 9781783553532
- Ovidiu, V. and Friess, P., (2014), "Internet of Things From Research and Innovation to Market Deployment," River Publishers, ISBN: 9788793102941, https://www.riverpublishers.com/pdf/ebook/RP\_E9788793102958.pdf
- 4. Ida, N., (2020), "Sensors, Actuators and Their Interfaces," SciTech Publishers, ISBN: 9781785618352
- 5. Pfister, C., (2011), "Getting Started with the Internet of Things," O'Reilly Media, ISBN:

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- Wallace, S., Richardson, M., Wolfram Donat, W., (2021), "Getting Started With Raspberry Pi: Getting to Know the Inexpensive ARM-Powered Linux Computer," Make Community, LLC, ISBN: 9781680456998
- Elangovan, U., (2019), "Smart Automation to Smart Manufacturing: Industrial Internet of Things," Momentum Press, ISBN: 9781949449266
- S. Jha, S., Tariq, U., Joshi, G. P., Solanki, V. K., (2022), "Industrial Internet of Things: Technologies, Design, and Applications," CRC Press, ISBN: 9780367607777
- 9. Schwartz, M., (2016), "Internet of Things with Arduino Cookbook," Packt Publishing, ISBN: 9781785286582
- 10. Kurniawan, A., (2019), "Internet of Things Projects with ESP32: Build exiting and powerful IoT projects using the all-new Expresif ESP32," Packt Publishing, ISBN: 9781789956870

#### Web References:

- 1. https://nptel.ac.in/courses/106105166
- 2. https://www.udemy.com/internet-of-things-iot-for-beginners-getting-started/
- 3. http://playground.arduino.cc/Projects/Ideas
- 4. http://www.megunolink.com/articles/arduino-garage-door-opener
- 5. http://www.willward1.com/arduino-wifi-tutorial
- 6. http://www.toptechboy.com/arduino-lessons
- 7. https://www.eprolabs.com
- 8. http://www.makeuseof.com/tag/pi-overdose-heres-5-raspberry-pi-alternatives

Course Code	Course Name	Credits
ARDLO8051	Product Design and Development	03

### **Course Objectives:**

- 1. To understand the basic concepts of engineering design and product design & development, focusing on the front-end processes.
- 2. To demonstrate an understanding of the overview of all the product design & development processes.
- 3. To demonstrate knowledge of concept generation and the selection of tools.
- 4. To study the applicability of product design & development in industrial applications.

**Course Outcomes:** Upon satisfactory completion of this course, the student will be able to:

- 1. Describe the process of product design & development.
- 2. Employ engineering, scientific, and mathematical principles to develop and execute a design project from a concept to a finished product.
- 3. Create 3D solid models of mechanical components using CAD software.
- 4. Demonstrate individual skills using selected manufacturing techniques such as rapid prototyping.
- 5. Fabricate an electromechanical assembly of a product from engineering drawings.
- 6. Work collaboratively in a team to complete a design project.
- 7. Effectively communicate the results of projects and other assignments both in a written and oral format.

Module	Details	Hours	CO Mapping
	Need for developing products, The importance of Engineering and Industrialdesign, The design process, Relevance of product lifecycle issues in design, Societal considerations in Engineering and Industrial Design, Canaria, product development process. Marious, phases of product		
01	development, planning for products, Establishing markets - market segments - relevance of market research.	07	CO1
02	The design processes, Descriptive and prescriptive design models, Concept development & evaluation, Pugh's total design activity model, Concept generation and selection method, Embodiment design, Product architecture, and Steps in developing product architecture.	07	CO2
03	Identifying customer needs, Voice of Customer (VoC), Customer populations, Hierarchy of human needs, Need gathering methods, Establishing engineering characteristics, Competitive benchmarking, QualityFunction Deployment (QFD), House of Quality (HoQ), Product design specification, Development of product design with specifications using QFD, Palayant case studies	07	CO3
04	Creative thinking, Creativity and problem-solving methods, Creative thinking methods, Brainstorming technique, Gorden technique, Check listing technique, Synectic technique, Morphological Analysis, and Attribute Listing technique. Generating design concepts, Systematic	07	CO4

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05	Industrial design, Basic forms & elements, Integrating basic forms & elements, Stellerigning ance, rhythm, proportion, The golden rule of proportions, human factors, and design, User-friendly design, Design for serviceability, Design for environment.	07	CO5	
	Concept of Design for Manufacturing and Assembly (DFMA). Role of			
06	computers in product design and manufacturing process, Prototyping techniques such as Stereolithography (SLA), Selective laser sintering (SLS), Fused disposition Modelling (FDM), Laminated object manufacturing (LOM), 3-D printing, and Ballistic Particle Manufacturing (BPM).	07	CO6	Te

#### **Books:**

- 1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development," 4<sup>th</sup> Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.
- 2. Kevin Otto, Kristin Wood, "Product Design," Indian Reprint 2004, Pearson Education, ISBN 9788177588217.

### **Reference Books:**

- 1. Clive L Dym, Patrick Little, "Engineering Design: A Project-based Introduction," 3<sup>rd</sup> Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7.
- 2. George E. Dieter, Linda C. Schmidt, "Engineering Design," 4<sup>th</sup> Edition, McGraw-Hill International Edition, 2009, ISBN 978-007-127189-9.
- 3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process," 2<sup>nd</sup> Edition Reprint, Cengage Learning, 2010, ISBN 0495668141

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Course Code	Course Name	Credits
ARDLO8052	Wireless Networks	03

### **Course Objectives:**

- 1. To analyze the fundamental architecture, design issues and standards of wireless networks.
- 2. To compare Personal Area Network (PAN) technologies such as ZigBee, Bluetooth, UWB, NFC and 6LoWPAN.
- 3. To classify different LAN topologies and technologies and ad hoc networks.
- 4. To classify network protocols, ad hoc vehicle networks and Wireless MANs.
- 5. To understand planning and design of GSM and CDMA system in Wireless WANs.
- 6. To apply Wireless sensor networks concepts to develop an IoT applications.

### **Course Outcomes:**

After successful completion of the course student will be able to:

- 1. Explain fundamental architecture, design issues and standards of wireless networks.
- 2. Compare different types of Personal Area Network (PAN) technologies such as ZigBee, Bluetooth UWB, NFC and 6LoWPAN.
- 3. Analyze different LAN topologies and technologies and ad hoc networks.
- 4. Compare various types of network protocols, ad hoc vehicle networks and Wireless MANs.
- 5. Evaluate the performance of GSM and CDMA system in Wireless WANs.
- 6. Apply the concepts of basic network architecture of Wireless sensor networks to develop an IoT applications.

Module	Contents	Hours	CO mapping
<b>Prerequ</b> System	<b>Prerequisite:</b> Pre-requisite: Computer Communication and Networks, Mobile Communication System		
1.	<ul> <li>Overview of wireless networks</li> <li>Wireless Networks: Architecture, Classifications, Switching technology, Communication Problems, Reference Models. Networking issues and Networking Standard.</li> <li>Wireless Body Area Networks: Properties, Network Architecture, Network components and Applications</li> </ul>	04	CO1
2.	Wireless Personal Area Networks WPAN: Bluetooth (802.15.1): Radio Specifications, Protocol Stack, Link Types, Security, Topologies, Applications.	12	CO2

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	ZigBee (802.15.4): Radio Specifications, Components, Topologies, ProtocolStack, Applications.RFID: Radio Specifications, Architecture, Types and applications.Near Field Communication & UWB (802.15.3 a): Introduction and working.		
	LoWPAN: Features, Architecture, protocol stack and applications		
3.	Wireless Local Area Network & Wireless Adhoc NetworksWireless Local Area Network: Equipment, Topologies, Technologies, Applications, Main features of IEEE802.11a,b, i and n, Protocol Architecture of WLANWireless AdhocNetworks: Features, advantages & ApplicationsMobile Adhoc Networks: Network Architecture, MAC Protocol.	06	CO3
4.	Wireless Metropolitan & Vehicular Adhoc Networks WMAN(IEEE802.16): Introduction, WMAN Network Architecture, NetworkProtocols, Broadband Wireless Networks, Applications Vehicular Adhoc Networks (VANETs): Characteristics, Protocols & Applications	05	CO4
5.	Wireless Wide Area Networks Planning and design of Wireless Networks, Radio design for a cellular Network Receiver sensitivity, Link budget for GSM and CDMA Systems, HSDPA	06	CO5
6.	Advanced Technologies of Wireless NetworksWireless Sensor Networks: Network Architecture, Design Considerations, NetworkProtocol Stack, and ApplicationsWireless Mesh Network: Network architecture, Protocols technologies & ApplicationsInternet of Things: IoT Conceptual Frame work, Architecture, Technology & Examples. M2M Communication	08	CO6

### **Internal Assessment:**

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

# **Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.

2. Total 4 questions need to be solved.

3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.

4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

# Text Books & References:

- 1. Vijay K. Garg, "Wireless Communication and Networking", Morgan -Kaufmann Series in Networking— Elsevier.
- 2. Kazem Sohraby, Daniel Minoli, and Taieb Znati, "Wireless Sensor Networks: Technology, Protocols, and Applications", Wiley Student Edition
- 3. Dr SunilkumarS. Manvi, Mahabaleshwar S. Kakkasageri, "Wireless and Mobile Networks Concepts and Protocol"Wiley India Pvt Ltd
- 4. Raj Kamal, "Internet of Things Architecture & amp; Design Principles" Mcgraw Hill

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	Course Code	Course Name	Credits
	ARDLO8053     Micro Electro Mechanical Systems (MEMS)		
Cour	se Objectives:		
1.	To realize the benefit	s and effects of scaling.	
2.	2. To understand properties and crystallography of Silicon		
3.	3. To learn the microfabrication techniques		
4.	To understand the pri	nciples and uses of micro systems	
	1		
Cour	se Outcomes:		
Aft	ter taking this course, le	earner should be able to:	
1.	Apply laws of scaling	for development of a MEMS device	
2.	2. Understand the materials and their processing to make MEMS		
3.	3. Select and use microfabrication techniques for microsystems		
4.	Understand the devel	opment of micro sensors and actuators	

- Analyze microsystems technology for technical feasibility as well as practicality
   Develop useful applications of MEMS.

Module	Contents	Hrs.	CO mapping	
1	Introduction to MEMS Unique characteristics of MEMS, Microsystems Technology- An Overview, typical MEMS and Microsystem Products, Scaling effects - scaling laws in miniaturization- Application of MEMS	05	CO1	
2	Material for MEMS and manufacturing Structure of silicon and other materials - Silicon wafer processing - Bulk micromachining and Surface micromachining, Wafer-bonding. Thin-film deposition, Lithography, wet etching and dry etching.	07	CO2	
3	Micro-fabrication methods LIGA and other moulding techniques- Soft lithography and polymer processing- Thick-film processing; Low temperature co-fired ceramic processing.			
4	MEMS components-micro sensors Micro sensors - Basic principles and working of micro sensors- Acoustic wave micro sensors- Bio-medical micro sensors- Bio-sensors- Chemical microsensors – Optical Sensors – Pressure micro sensors- Thermal micro sensors-acceleration micro sensors;	08	CO4	
5	Micro-actuators Basic principles and working of micro actuators- Electrostatic micro actuators- Piezoelectric micro actuators- Thermal micro actuators- SMA micro actuators- Electromagnetic micro actuators, micro valves, micro pumps.	06	CO5	
6	Case studies /research based on MEMS applications-impact of materials, processes and design, Actuation using Shape Memory Alloys, Medical device, micropumps	04	CO6	

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# Text books:

- 1. MEMS and Microsystems Design and Manufacture by Tai-Ran Hsu, Tata McGraw-Hill Publishing Company Ltd.
- 2. Foundation of MEMS by Chang Liu, Pearson Education

### **References:**

- Fundamentals of Microfabrication and Nanotechnology, by Marc J. Madou, CRC Press, 2011, ISBN: 9780849331800
- Micromachined Transducers Sourcebook, by Gregory Kovacs, WCB McGraw-Hill, Boston, 1998, ISBN: 9780071164627
- Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes, by M.H. Bao, Elsevier, New York, 2000, ISBN: 978-0444505583
- Microsystem Design, by Stephen D Senturia, Springer Publication, 2000, ISBN:9780792372462.
- Micro sensors Principles and Applications, by Julian W. Gardner, John Wiley & Sons, Inc. 1994, ISBN: 9780471941361.

Course Code:	Course Title	Credit
ARDLO8054	Deep Learning	3

Prerequisite: Basic mathematics and Statistical concepts, Linear algebra, Machine Learning

### **Course Objectives:**

- 1 To learn the fundamentals of Neural Network.
- 2 To gain an in-depth understanding of training Deep Neural Networks.
- 3 To acquire knowledge of advanced concepts of Convolution Neural Networks, Autoencoders and Recurrent Neural Networks.
- 4 Students should be familiar with the recent trends in Deep Learning.

### **Course Outcomes:**

- 1 Gain basic knowledge of Neural Networks.
- 2 Acquire in depth understanding of training Deep Neural Networks.
- 3 Design appropriate DNN model for supervised, unsupervised and sequence learning applications.
- 4 Gain familiarity with recent trends and applications of Deep Learning.

Module	Content	Hrs
1	Fundamentals of Neural Network Biological neuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron: Linearly separable, linearly non- separable classes. Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning	04
2	<ul> <li>Training, Optimization and Regularization of Deep Neural Network</li> <li>Training Feedforward DNN</li> <li>Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function</li> <li>Optimization</li> <li>Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov</li> </ul>	10

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	<ul> <li>Accelerated GD, AdaGrad, Adam, RMSProp</li> <li>Regularization</li> <li>Overview of Overfitting, Types of biases, Bias Variance Tradeoff</li> <li>Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout,</li> <li>Weight Decay, Batch normalization, Early stopping, Data</li> <li>Augmentation, adding noise to input and output</li> </ul>	
3	Autoencoders: Unsupervised LearningIntroduction, Linear Autoencoder, Undercomplete Autoencoder,Overcomplete Autoencoders, Regularization in AutoencodersDenoising Autoencoders, Sparse Autoencoders, ContractiveAutoencodersAutoencodersApplication of Autoencoders: Image Compression	06
4	Convolutional Neural Networks (CNN): Supervised Learning Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture	07
5	Recurrent Neural Networks (RNN)Sequence Learning Problem, Unfolding Computational graphs, RecurrentNeural Network, Bidirectional RNN, Backpropagation Through Time (BTT),Vanishing and Exploding Gradients, TruncatedBTTLong Short Term Memory: Selective Read, Selective write, SelectiveForget, Gated Recurrent Unit	08
6	Recent Trends and Applications Generative Adversarial Network (GAN): Architecture, Applications: Image Generation, DeepFake	04

# Internal Assessment:

The assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

# **End Semester Theory Examination:**

- 1 Question paper will comprise a total of six questions.
- 2 All questions carry equal marks.
- 3 Question 1 and question 6 will have questions from all modules. Remaining 4 questions will be based on the remaining 4 modules.
- 4 Only four questions need to be solved.

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5 In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

# **Textbooks:**

- 1 Ian Goodfellow, Yoshua Bengio, Aaron Courville. "Deep Learning", MIT Press Ltd, 2016
- 2 Li Deng and Dong Yu, "Deep Learning Methods and Applications", Publishers Inc.
- 3 Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
- 4 JM Zurada "Introduction to Artificial Neural Systems", Jaico Publishing House
- 5 M. J. Kochenderfer, Tim A. Wheeler. "Algorithms for Optimization", MIt Press.

# **References:**

- Buduma, N. and Locascio, N., "Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
- 2 François Chollet. "Deep learning with Python "(Vol. 361). 2018 New York: Manning.
- 3 Douwe Osinga. "Deep Learning Cookbook", O'REILLY, SPD Publishers, Delhi.
- 4 Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc
- 5 S. N. Sivanandam and S. N. Deepa, Principles of soft computing-Wiley India

# **Useful Links**

- 1 <u>https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html</u>
- 2 http://www.cse.iitm.ac.in/~miteshk/CS6910.html
- 3 <u>https://nptel.ac.in/courses/106/106/106106184/</u>
- 4 <u>https://www.deeplearningbook.org/</u>

Course Code	Course Name	Credits
ARDLO8061	<b>Operations Planning and Control</b>	3

### **Course Objectives:**

- 1. To provide an exposure to Operations Planning & Control (PPC) and its significance in manufacturing and service organizations
- 2. To appraise about need and benefits of planning functions related to products and processes
- 3. To provide exposure to production scheduling, sequencing and project management so as to optimize resources
- 4. To provide insights into MRP and ERP to minimize the total cost and to manage operations functions in a better way
- 5. To demonstrate different techniques used for facility planning and assembly line balancing
- 6. To develop an understanding of JIT, Lean, Agile and Synchronous Manufacturing system

### Course Outcomes: Learner will be able to...

- 1. Illustrate operations functions and manage operations in a better way.
- 2. Apply various strategies to develop aggregate production plans based on the demand forecasting.
- 3. Apply various algorithms in scheduling and sequencing of manufacturing and service operations
- 4. Develop Material Requirements Plans (MRP) to estimate the planned order releases.
- 5. Apply various techniques for facility layout planning and line balancing to optimize the resources
- 6. Demonstrate the importance of implementation of JIT, Lean, Agile and Synchronous manufacturing in manufacturing and service organizations.

Module	Detailed Contents	Hrs.	CO Manning
1.	<ul> <li>1.1 Introduction: Production and Operations Function, Production systems, make to stock, Make to order, Assemble to order and Engineer to order, type of layouts, Phases in OPC like Preplanning, Planning, Action &amp; Control.</li> <li>1.2 Strategic Planning for Operations and Services: Approaches like Forced Choice model and Operations Model, Quality and Productivity strategy, Technology strategy. Operations Strategies for Services, Types or Service Operations: Quasi manufacturing, Customer as participants, Customer as product, Classification of Services, Service capacity.</li> </ul>	6	CO1
2.	2.1 Forecasting: Forecasting and Prediction, Need for forecasting, role of forecasting in OPC, Methods of forecasting, Qualitative methods, Quantitative methods like time series analysis, least square method, moving average method, and exponential smoothing method. Forecasting Error; Mean Absolute Deviation, Forecasting Bias 2.2 Capacity Planning: Measurement of capacity, Measures of operating capacity, Factors influencing effective capacity, factors favoring over capacity and under capacity, short range, medium range and long range capacity planning. Capacity requirement Planning	8	CO2

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	<ul> <li>(CRP)</li> <li>2.3 Aggregate planning: Concept of aggregate planning, Pure Strategy;</li> <li>Mixed Strategy; Level Strategy, Rough cut capacity planning,</li> <li>Aggregate planning for Services; Optimal Models for Aggregate</li> <li>Planning; Linear Programming; Linear Decision Rules Master</li> <li>Production Schedule</li> </ul>		
3.	<ul> <li>3.1 Job shop/Intermittent Manufacturing Scheduling: Factors influencing scheduling, Inputs for scheduling, Forward Scheduling, Backward Scheduling, Stages in Scheduling: Product sequencing, Loading and Dispatching, dispatching, progress report &amp; expediting and control. Basic scheduling problems, Priority Sequencing, Gantt Charts, Johnson's Rule for optimal sequence of N jobs on 2 machines. Process N Jobs on 3 Machines (N/3 problem) and Jackson Algorithm. Processing of 2 Jobs on M Machine (2/M) problem,</li> <li>3.2 Project scheduling: Network analysis - PERT &amp; CPM, cost analysis &amp; crashing, resource leveling and smoothening.</li> </ul>	8	CO3
4.	<ul> <li>4.1 Material Requirement Planning: Introduction, Limitations of conventional EOQ, Objectives of MRP, Inputs of MRP-I, Outputs of MRP, MRP lot sizing and Estimation of planned order releases, Manufacturing resource planning (MRP-II)</li> <li>4.2 Enterprise Resource Planning (ERP): Evolution, features, purpose of modeling an enterprise, ERP model for OPC, Modules in ERP, ERP Implementation Life Cycle, ERP packages like SAP-R3/Baan/PeopleSoft</li> </ul>	6	CO4
5.	<ul> <li>5.1 Facility layout planning: Factors influencing Plant Layout, Material Flow Patterns, Tools and Techniques used for Plant Layout Planning.</li> <li>5.2 Line Balancing: Objectives, constraints, terminology in assembly line, heuristic methods like Kilbridge-Wester, Largest Candidate rule, Rank positional weight</li> </ul>	6	CO5
6.	Introduction to JIT system, Lean, Agile and Synchronous manufacturing: Concept, Characteristics, Components and Implementation.	5	CO6

# **Internal Assessment for 20 marks:**

Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and

second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

# **End Semester Examination:**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks

2. Question 1 will be compulsory and should cover maximum contents of the curriculum

3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part

(b) will be from any module other than module 3)

4. Only Four questions need to be solved.

### **Text/Reference Books:**

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- "Production and Operations Management", K. Aswathappa & K. Shridhara Rao, Himalaya Publishing House, Revised 2nd Edition (2008)
- 2. "Industrial Engineering and Production Management", Martand Telsang, S. Chand, New Delhi (2009)
- 3. "Modern Production operations Management", Elwood S Buffa and Rakesh K Sarin, 8th Edition, Wiley Eastern, New York (1999) ISBN: 978-0471819059
- 4. "Production and Operations Management", Panneer Selvan R, 3rd Edition 2002 Prentice Hall India, New Delhi, ISBN: 978-8120345553
- 5. "Production Planning and Control", Samuel Eilon, Universal Publication, ISBN: 9788185027548
- 6. "Production Planning and Control", L C Jhamb ,12th Edition 2010, Everest Pub House.
- "Production Planning and Control", W. Bolton-Longman Scientific & Technical (1994), ISBN: 978-0582228207
- Production Systems- Planning, Analysis & Control", James. L. Riggs, John, 4th Edition 1987, Wiley & Sons, ISBN: 9780471847939
- Manufacturing Planning and Control Systems, Thomas E. Vollman, William L. Berry & Others,4th Edition 1997, McGraw Hill Pub, ISBN: 978-0786312092
- 10. "Manufacturing Process Planning and Systems Engineering", Anand Bewoor, Dreamtech Press 2009, ISBN: 978-8177229967
- 11. "Production and Operations Management", S.N. Chary, 3rd Edition 2004, TMH publishing company, ISBN: 978-0070583559
- 12. Modernization & Material Management, L.C. Jhamb Everest Publishing House

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Course Code	Course Name	Credits
ARDLO8062	Autonomous Vehicles	3

#### **Course Objectives:**

- 1. Introduction to Autonomous vehicles/SDC (Self Driving Cars), advantages and challenges in SDC's.
- 2. Gain Knowledge about the Sensors in SDC's.
- 3. Understand the in- vehicle communication aspects in SDC's
- 4. Understand perception and localization in SDC.
- 5. Get to grips with planning and control in SDC.
- 6. To know the various applications of SDC's.

### **Course Outcome:**

After successful completion of the course student will be able to

- 1. Understand fundamentals of SDC (Self Driving Cars).
- 2. Compare different types of Sensors in SDC's.
- 3. Illustrate different protocols of In vehicle communication for SDC's.
- 4. Identify perception and localization in SDC's.
- 5. Analyze planning and control in SDC.
- 6. Evaluate different applications and algorithms in SDC's.

Module	Detailed Contents	Hrs.	CO Mapping
1.	Introduction Introduction to Autonomous Vehicles /Self Driving cars (SDC), Benefits of SDCs, Challenges in Current Deployment. Levels of Autonomy	04	CO1
2.	Sensors in Autonomous Vehicles Camera (3D and stereo), LiDAR, Sensor Fusion Passive Perception with Sonar and Millimeter Wave Radar Vehicle-to-Everything Infrastructure	06	CO2
3.	In-Vehicle Communication Systems CAN: Introduction and architecture CAN open: Introduction and architecture FlexRay protocol: Introduction and architecture Introduction to Operating System for SDC's	08	CO3
4.	<ul> <li>Perception and Localization in SDC</li> <li>Introduction to Computer vision in SDC. Artificial eyes VS human eyes.</li> <li>Four pillars of autonomous driving: Perception, Localization, Planning and Control.</li> <li>Perception: Object Detection and Line Lane detection</li> <li>Object/ obstacle Detection: Comparison of 2D and 3D object detection.</li> <li>Overview of ML algorithms for obstacle detection-Histogram of Oriented Gradients (HOG), Support Vector Machine (SVM).</li> <li>Object detection using deep learning algorithm: Architecture of YOLO Line Lane Detection: Introduction to Semantic Segmentation, architecture, overview of different semantic segmentation architecture.</li> </ul>	09	CO4

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	Localization: Introduction to GNSS, GNSS error analysis, Visual Odometry, SLAM Self-Learning: Implementation of YOLO for object Detection, Implementation of semantic segmentation for images.		
5.	Planning and Control in SDC Planning and Control: Architecture of planning and control, Traffic Prediction and routing. Behavioral decision, Motion Planning and feedback control.	06	CO5
6.	Applications of SDC DragonFly Model: Sensor Configuration and Software Architecture Enabling Commercial Autonomous Space Robotic Explorers: Sensor configuration and its working. Algorithm for YOLO object detection: Detecting objects in images and Detecting objects in videos	06	CO6

### **Internal Assessment for 20 marks:**

Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and

second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

#### **End Semester Examination:**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part
- (b) will be from any module other than module 3)

4. Only Four questions need to be solved.

### **Textbooks:**

- 1. Sumit Ranjan, Dr. S. Senthamilarasu Applied Deep Learning and Computer Vision for Self- Driving Cars, Packt Publishing Ltd. 2020.
- Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot Creating Autonomous Vehicle System, Second Edition, Morgan & Claypool Publishers, 2018.
- 3. William Ribbens Understanding- Automotive-Electronics, Butterworth-Heinemann Publisher, Fifth Edition, 1998.

### **Reference Books:**

- Markus Maurer ,J. Christian Gerdes, Barbara Lenz , Hermann Winner Autonomous Driving Technical, Legal, Social Aspects , Springer Open, 2015.
- 2. Shaoshan Liu Engineering Autonomous Vehicles and Robots, Wiley, 2020.

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### **E-Resources:**

- 1. Open Innovation in EVs: A case study of Tesla Motors https://www.diva-portal.org/smash/get/diva2:635929/FULLTEXT01.pdf
- 2. Autonomous vehicles Research report by MRCagney <u>https://drive.google.com/drive/folders/1nxROagqwDKUpVMDLFPPgG7\_DKaku</u> <u>yItf</u>
- 3. Reinventing Safety: A Joint Approach to Automated Driving Systems Mercedes Benz and Bosch

https://www.daimler.com/documents/innovation/other/vssa-mercedes-benzand- bosch.pdf

# **Online Courses**

- 1. https://digitaldefynd.com/best-self-driving-cars-courses/
- 2. https://www.classcentral.com/course/intro-self-driving-cars-13140

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Course Name	Credits
Total Quality Management	03
	Course Name Total Quality Management

# **Course Objectives:**

- 1. To understand the importance of Quality Management and principles of TQM
- 2. To understand seven basic QC tools and advanced QM tools
- 3. To understand the concept of Statistical Quality Control
- 4. To understand the concept of Continuous Improvement and TQM implementation
- 5. To understand different Quality Systems and Quality Standards
- 6. To understand the future trends in TQM and TQM strategies

**Course Outcomes:** The students will be able to use the tools and techniques of **TQM** in the manufacturing and service sectors.

- 1. To apply QM and principles of TQM in organizational development process.
- To apply the QC & QM tools in process improvement.
- To apply the QC techniques to improve process quality.
- To apply SQC techniques to improve process quarty.
   To apply Six Sigma project in TQM Implementation
- 5. To apply QMS and Certification for Quality Accreditation
- 6. To apply the advanced tools for Quality Sustainability.

Module	Contents	Hours	CO Mapping
1	<ul> <li>Introduction to Quality Management :</li> <li>A) Definitions of Quality, product quality and service quality; the evolution quality; need for Quality Management, Quality statements and Policy, Customer orientation &amp; satisfaction, Customer complaints, customer retention; Supplier partnership, Supplier rating &amp; selection, CSI, Costs of Quality, Prevention, appraisal and failure aspects, Use of COQ for improving quality and performance, Designing for quality, Quality of design, Quality of conformance.</li> <li>B) Basic concepts of TQM, TQM framework, Contributions of Deming, Juran and Crosby, Juran Triology, PDCA Cycle, Barriers to TQM; TQM principles; Strategic Quality Planning; Quality councils; employee involvement, motivation; Empowerment; Team and Teamwork; recognitionand reward, performance appraisal.</li> </ul>	08	CO1
2	QC Tools: A) Seven QC Tools: Check Sheet, Histogram, Pareto Chart, Fishbone Diagram, Run Charts, Scatter Diagram, Process Flow Chart. B) Seven QM Tools: Program Decision Process Chart, Tree Diagram, Affinity Diagram, Prioritization Matrix, etc. Bench Marking Types – Process, Product, Quality Improvement Tools: Why-Why Analysis, Root Cause Analysis, Poka Yoke (Mistake Proofing)	06	CO2

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		-	
3	<ul> <li>Statistical Quality Control: 100% Inspection versus Sampling Inspection, Reasons for SQC.</li> <li>A) Acceptance Sampling: Concept of Producer Risk and Consumers Risk.Operating Characteristics Curve. Sampling Plan – Single Sampling Plan versus Double Sampling Plan. Design Sampling Plan on the basis of MIL, ASQ Standards.</li> <li>B) Statistical Process Control: Variations – Concept, Causes – Random &amp; Assignable, Difference – Process in Control versus Process is Capable, Control Charts, X-Bar, R, P and C Charts, Process Capability (Cp) &amp; ProcessCapability Index (Cpk), Sigma Limits. Applications of Control Charts in Mass Production, Process Production.</li> </ul>	06	CO3
4	<ul> <li>A) Continuous Improvement: Quality Circles, Quality Function Development (QFD), Taguchi quality loss function, Parameter Design, Robust Design; TPM- concepts, 5S, Kaizen, FMEA- stages, Zero Defect.</li> <li>B) TQM Implementation: Manufacturing and Service sectors, Introductionto Six Sigma: Definition, Concept, Methodology. Six Sigma Approaches – Design for Six Sigma (DFSS) Approach &amp; DMAIC Approach, Six Sigma Tools: Applications to manufacturing and service sector including IT, ITeS, and E Com</li> </ul>	08	CO4
5	Quality Management System & Certification:A) QMS: Elements and documentation, Quality auditing, Necessity for Certification & Certification Process, Benefits of Certification. Certifying Bodies & Accreditation Agencies, ISO 9000-2015 (5th Edition), Introductionto TS16949: Technical Specifications, QS9000, ISO14000- concepts, requirements and benefits. Case studies of TQM implementation in manufacturing and service sectors including IT and Environmental management systems- ISO 14000 Series Standards, Integration of ISO 14000 with ISO 9000.B) Quality Awards: Malcom Baldrige National Quality Award and Rajiv Gandhi National Quality award.	06	CO5
6	Future Trends in TQM : Strategic approach to leadership , Customer centric endeavors , Involvement & empowerment of all employees / stake holders , Decision making based on real time facts , Win-Win policy with suppliers , New paradigms of Green & sustainability , TQM beyond Manufacturing i.e. Healthcare, Education, Finance. Accountability through new tools and technologies, Quality Analytics.	06	CO6

# **Internal Assessment for 20 marks:**

Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

# **End Semester Examination:**

University of Mumbai

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b)

will be from any module other than module 3)

4. Only Four questions need to be solved.

### **Text Books:**

- 1. Besterfield D.H. et al.: Total quality Management, 3<sup>rd</sup> Edition, Pearson Education Asia, 2006.
- 2. Janakiraman B. and Gopal R.K.: Total Quality Management, Prentice Hall India, 2006.
- 3. Poornima M. Charantimath: Total Quality Management, 2<sup>nd</sup> Edition, Pearson Education Asia, 2006.
- 4. N. Logothetis: Managing for Total Quality, 6<sup>th</sup> Edition, Prentice Hall of India Pvt. Ltd. 2003.
- 5. Suganthi L. and Samuel A.: Total Quality Management, Prentice Hall India, 2006.
- 6. Evans J.R. and Lindsay W.M.: The Management and Control of Quality, 8<sup>th</sup> Edition, 1<sup>st</sup> Indian Edition, Cengage Learning, 2012.

Course Code	Course Name	Credit
ARDLO8064	Social Media Analytics	03

**Prerequisite:** Graph Theory, Data Mining, Python/R programming

Course Objectives: The course aims:

- 1 Familiarize the learners with the concept of social media.
- 2 Familiarize the learners with the concept of social media analytics and understand its significance.
- 3 Enable the learners to develop skills required for analyzing the effectiveness of social media.
- 4 Familiarize the learners with different tools of social media analytics.
- 5 Familiarize the learner with different visualization techniques for Social media analytics.
- 6 Examine the ethical and legal implications of leveraging social media data.

### **Course Outcomes:**

- 1 Understand the concept of Social media
- 2 Understand the concept of social media Analytics and its significance.
- 3 Learners will be able to analyze the effectiveness of social media
- 4 Learners will be able to use different Social media analytics tools effectively and efficiently.
- 5 Learners will be able to use different effective Visualization techniques to represent social media analytics.
- 6 Acquire the fundamental perspectives and hands-on skills needed to work with social media data.

Module	Detailed Content	Hours	CO Mapping
1.	<ul> <li>Social Media Analytics: An Overview</li> <li>Core Characteristics of Social Media, Types of Social Media, Social media landscape, Need for Social Media Analytics (SMA), SMA in small &amp; large organizations.</li> <li>Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools</li> </ul>	06	CO1
2.	Social Network Structure, Measures & Visualization		

University of Mumbai

	<ul> <li>Basics of Social Network Structure - Nodes, Edges &amp; Tie Describing the Networks Measures - Degree Distribution, Density, Connectivity, Centralization, Tie Strength &amp; Trust</li> <li>Network Visualization - Graph Layout, Visualizing Network features, Scale Issues.</li> <li>Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools.</li> </ul>	6	CO2
3.	Social Media Text, Action & Hyperlink Analytics Social Media Text Analytics - Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text Analysis Tools Social Media Action Analytics - What Is Actions Analytics? Common Social Media Actions, Actions Analytics Tools Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools	8	CO3
4.	Social Media Location & Search Engine Analytics Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools	6	CO4
5.	Social Information Filtering Social Information Filtering - Social Sharing and filtering, Automated Recommendation systems, Traditional Vs social Recommendation Systems Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks	6	CO5
6.	<ul> <li>Social Media Analytics Applications and Privacy</li> <li>Social media in public sector - Analyzing public sector social media, analyzing individual users, case study.</li> <li>Business use of social media - Measuring success, Interaction and monitoring, case study.</li> <li>Privacy - Privacy policies, data ownership and maintaining privacy online.</li> </ul>	7	CO6

# **Internal Assessment for 20 marks:**

Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

# **End Semester Examination:**

Weightage of each module in the end semester examination will be proportional to the number of respective

lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks University of Mumbai

2. Question 1 will be compulsory and should cover maximum contents of the curriculum

3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b)

will be from any module other than module 3)

4. Only Four questions need to be solved.

### **Textbooks:**

- Seven Layers of Social Media Analytics\_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, Gohar F. Khan,(ISBN-10: 1507823207).
- 2. Analyzing the Social Web 1st Edition by Jennifer Golbeck
- 3. Mining the Social Web\_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, Matthew A Russell, O'Reilly
- 4 Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

### **References:**

- 1. Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, Avinash Kohirkar, IBM Press
- 2. Social Media Analytics Strategy\_ Using Data to Optimize Business Performance, Alex Gonçalves, APress Business Team
- 3. Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulus (2019), Wiley, ISBN 978-1-118-82485-6

### **Useful Links**

- 1 https://cse.iitkgp.ac.in/~pawang/courses/SC16.html
- 2 https://onlinecourses.nptel.ac.in/noc20\_cs78/preview
- 3 https://nptel.ac.in/courses/106106146
- 4 https://7layersanalytics.com/

<b>Course Code</b>	Course Name	Credits
ILO8021	Project Management	03

### **Objectives:**

- 1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- 2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to...

- 1. Apply selection criteria and select an appropriate project from different options.
- 2. Write work break down structure for a project and develop a schedule based on it.
- 3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- 4. Use Earned value technique and determine & predict status of the project.
- 5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stagegate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	05
02	Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective projectteam, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	06
03	<b>Project Planning and Scheduling:</b> Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	08
04	<ul> <li>Planning Projects:</li> <li>Crashing project time, Resource loading and levelling, Goldratt's critical chain,</li> <li>Project Stakeholders and Communication plan</li> <li>Risk Management in projects: Risk management planning, Risk identification and</li> <li>risk register, Qualitative and quantitative risk assessment, Probability and impact</li> <li>matrix. Risk response strategies for positive and negative risks</li> </ul>	06

	5.1 Executing Projects:	
05	<ul> <li>Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings</li> <li><b>5.2 Monitoring and Controlling Projects:</b></li> <li>Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit</li> <li><b>5.3 Project Contracting</b></li> <li>Project procurement management, contracting and outsourcing,</li> </ul>	08
06	<ul> <li>6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects</li> <li>6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.</li> </ul>	06

# **Internal Assessment for 20 marks:**

### Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

# **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved

# **REFERENCES:**

- 1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7<sup>th</sup> Edition, Wiley India
- 2. A Guide to the Project Management Body of Knowledge (PMBOK<sup>®</sup> Guide), 5<sup>th</sup> Ed, Project Management Institute PA, USA
- 3. Project Management, Gido Clements, Cengage Learning
- 4. Project Management, Gopalan, Wiley India
- 5. Project Management, Dennis Lock, 9<sup>th</sup> Edition, Gower Publishing England

University of Mumbai

Course Code	Course Name	Credits
11.0 8022	Finance Management	03

### **Objectives:**

- 1. Overview of Indian financial system, instruments and market
- 2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- 3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to...

- 1. Understand Indian finance system and corporate finance
- 2. Take investment, finance as well as dividend decisions

Detailed Contents	Hrs
Overview of Indian Financial System: Characteristics, Components and	
Functions of Financial System.	
Financial Instruments: Meaning, Characteristics and Classification of Basic	
Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures,	
Certificates of Deposit, and Treasury Bills.	06
Financial Markets: Meaning, Characteristics and Classification of Financial	
Markets — Capital Market, Money Market and Foreign Currency Market	
Financial Institutions: Meaning, Characteristics and Classification of Financial	
Institutions — Commercial Banks, Investment-Merchant Banks and Stock	
Exchanges	
Concepts of Returns and Risks: Measurement of Historical Returns and	
Expected Returns of a Single Security and a Two-security Portfolio; Measurement	
of Historical Risk and Expected Risk of a Single Security and a Two-security	
Portfolio.	06
Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and	
Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due;	
Continuous Compounding and Continuous Discounting.	
Overview of Corporate Finance: Objectives of Corporate Finance; Functions of	
Corporate Finance-Investment Decision, Financing Decision, and Dividend	
Decision.	
Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet,	09
Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio	
Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios;	
Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
	Detailed Contents           Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.           Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.           Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market           Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges           Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.           Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.           Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.

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04	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	<b>Dividend Policy:</b> Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

# **Internal Assessment for 20 marks:**

### Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

# End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

### **REFERENCES:**

- 1. Fundamentals of Financial Management, 13<sup>th</sup> Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
- 2. Analysis for Financial Management, 10<sup>th</sup> Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
- 3. Indian Financial System, 9<sup>th</sup> Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
- 4. Financial Management, 11<sup>th</sup> Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

University of Mumbai

Course Code	Course Name Entrepreneurship Development and	Credits
1100025	Management	03

# **Objectives:**

- 1. To acquaint with entrepreneurship and management of business
- 2. Understand Indian environment for entrepreneurship
- 3. Idea of EDP, MSME

Outcomes: Learner will be able to...

- 1. Understand the concept of business plan and ownerships
- 2. Interpret key regulations and legal aspects of entrepreneurship in India
- 3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations Women's Entrepreneurship Development, Social entrepreneurship-role and need,	09
03	EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	<b>Indian Environment for Entrepreneurship:</b> key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	<b>Effective Management of Business:</b> Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08

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	Achieving Success In The Small Business: Stages of the small business life	
06	cycle, four types of firm-level growth strategies, Options - harvesting or closing	05
00	small business Critical Success factors of small business	

#### **Internal Assessment for 20 marks:**

#### Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

#### **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

### **REFERENCES:**

- 1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
- 2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
- 3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
- 4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
- 5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
- 6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
- 7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
- 8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
- 9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
- 10. Laghu Udyog Samachar
- 11. www.msme.gov.in
- 12. www.dcmesme.gov.in
- 13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

### **Objectives:**

- 1. To introduce the students with basic concepts, techniques and practices of the human resource management
- 2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
- 3. To familiarize the students about the latest developments, trends & different aspects of HRM
- 4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

**Outcomes:** Learner will be able to...

- 1. Understand the concepts, aspects, techniques and practices of the human resource management.
- 2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- 3. Gain knowledge about the latest developments and trends in HRM.
- 4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	<ul> <li>Introduction to HR</li> <li>Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions</li> <li>Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues</li> </ul>	05
02	<ul> <li>Organizational Behaviour (OB)</li> <li>Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues</li> <li>Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for IncreasingSelf Awareness</li> <li>Perception: Attitude and Value, Effect of perception on Individual Decision- making, Attitude and Behaviour</li> <li>Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor);</li> <li>Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performingteams, Team Roles, cross functional and self-directed team.</li> <li>Case study</li> </ul>	07
03	<ul> <li>Organizational Structure &amp;Design</li> <li>Structure, size, technology, Environment of organization; Organizational Roles&amp; conflicts: Concept of roles; role dynamics; role conflicts and stress.</li> </ul>	06

	<ul> <li>Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.</li> <li>Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.</li> </ul>	
	Human resource Planning	
	• Recruitment and Selection process, Job-enrichment, Empowerment - Job-	
04	Satisfaction, employee morale	05
04	• Performance Appraisal Systems: Traditional & modern methods, Performance	03
	Counselling, Career Planning	
	Training & Development: Identification of Training Needs, Training Methods	
	Emerging Trends in HR	
	• Organizational development; Business Process Re-engineering (BPR), BPR as a	
	tool for organizational development, managing processes & transformation in HR.	
05	• Creas Cultural Loadership and Decision Making: Creas Cultural Communication and	06
	• Closs Cultural Leadership and Decision Making: Closs Cultural Communicationand diversity at work, causes of diversity, managing diversity with special reference to	
	handicapped women and ageing people intra company cultural difference in	
	employee motivation	
	<b>HR &amp; MIS:</b> Need, purpose, objective and role of information system in HR	
	Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport,	
	Hospitals, Hotels and service industries	
	Strategic HRM: Role of Strategic HRM in the modern business world, Concept of	
06	Strategy, Strategic Management Process, Approaches to Strategic Decision Making;	10
	Strategic Intent – Corporate Mission, Vision, Objectives and Goals	
	Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations,	
	Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shopsand	
	Establishments Act	

# **Internal Assessment for 20 marks:**

# Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

# **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

#### **References:**

- 1. Stephen Robbins, Organizational Behavior, 16<sup>th</sup> Ed, 2013
- 2. V S P Rao, Human Resource Management, 3<sup>rd</sup> Ed, 2010, Excel publishing
- 3. Aswathapa, Human resource management: Text & cases, 6<sup>th</sup> edition, 2011
- 4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15<sup>th</sup> Ed, 2015, Himalaya Publishing, 15<sup>th</sup>edition, 2015
- 5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5<sup>th</sup> Ed, 2013, Himalaya Publishing
- 6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

University of Mumbai

Cours Code	e Course Name	Credits
ILO8025 Professional Ethics and Corporate Social Responsibility (CSR)		03
<b>bjectives:</b> 1. To u	nderstand professional ethics in business	
2. To re	ecognized corporate social responsibility	
1. Unde 2. Disti 3. Dem 4. Unde	Learner will be able to erstand rights and duties of business nguish different aspects of corporate social responsibility onstrate professional ethics erstand legal aspects of corporate social responsibility	
Module	Detailed Contents	Hrs
01	<b>Professional Ethics and Business:</b> The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	<b>Professional Ethics in the Marketplace:</b> Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy <b>Professional Ethics and the Environment:</b> Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	<ul> <li>Professional Ethics of Consumer Protection: Markets and Consumer Protectio Contract View of Business Firm's Duties to Consumers; Due Care Theor Advertising Ethics; Consumer Privacy</li> <li>Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.</li> </ul>	n; y; 06
04	<b>Introduction to Corporate Social Responsibility:</b> Potential Business Benefits- Triple bottom line, Human resources, Risk management, Supplier relation Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	us; 05
05	<b>Corporate Social Responsibility:</b> Articulation of Gandhian Trusteeship Corpora Social Responsibility and Small and Medium Enterprises (SMEs) inIndia, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	te <b>08</b>
06	Corporate Social Responsibility in Globalizing India: Corporate Soci Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corpora	al te <b>08</b>

Affairs, Government of India, Legal Aspects of Corporate Social Responsibility-

Companies Act, 2013.

06

### **Internal Assessment for 20 marks:**

### Consisting Two Compulsory Class Tests

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### **End Semester Examination:**

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- 4. Only Four questions need to be solved.

### **References:**

- **1.** Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
- 2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
- **3.** Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
- 4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

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Course Code	Course Name	Credits
ILO8026	<b>Research Methodology</b>	03

### **Objectives:**

- 1. To understand Research and Research Process
- 2. To acquaint students with identifying problems for research and develop research strategies
- 3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to...

- 1. Prepare a preliminary research design for projects in their subject matter areas
- 2. Accurately collect, analyze and report data
- 3. Present complex data or situations clearly
- 4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	<ul> <li>Introduction and Basic Research Concepts</li> <li>1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology</li> <li>1.2 Need of Research in Business and Social Sciences</li> <li>1.3 Objectives of Research</li> <li>1.4 Issues and Problems in Research</li> <li>1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical</li> </ul>	09
02	Types of Research2.1. Basic Research2.2. Applied Research2.3. Descriptive Research2.4. Analytical Research2.5. Empirical Research2.6 Qualitative and Quantitative Approaches	07
03	<ul> <li>Research Design and Sample Design</li> <li>3.1 Research Design – Meaning, Types and Significance</li> <li>3.2 Sample Design – Meaning and Significance Essentials of a good sampling</li> <li>Stages in Sample Design Sampling methods/techniques Sampling Errors</li> </ul>	07
04	<ul> <li>Research Methodology</li> <li>4.1 Meaning of Research Methodology</li> <li>4.2. Stages in Scientific Research Process: <ul> <li>a. Identification and Selection of Research Problem</li> <li>b. Formulation of Research Problem</li> <li>c. Review of Literature</li> <li>d. Formulation of Hypothesis</li> <li>e. Formulation of research Design</li> </ul> </li> </ul>	08

	f. Sample Design	
	g. Data Collection	
	h. Data Analysis	
	i. Hypothesis testing and Interpretation of Data	
	j. Preparation of Research Report	
	Formulating Research Problem	
05	5.1 Considerations: Relevance, Interest, Data Availability, Choice of data,	04
	Analysis of data, Generalization and Interpretation of analysis	
	Outcome of Research	
06	6.1 Preparation of the report on conclusion reached	04
00	6.2 Validity Testing & Ethical Issues	V4
	6.3 Suggestions and Recommendation	

### **Internal Assessment for 20 marks:**

### Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

#### **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

### **References:**

- 1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
- 2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
- 3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2<sup>nd</sup>ed), Singapore, Pearson Education

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Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

### **Objectives:**

- 1. To understand intellectual property rights protection system
- 2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- 3. To get acquaintance with Patent search and patent filing procedure and applications

**Outcomes:** Learner will be able to...

- 1. understand Intellectual Property assets
- 2. assist individuals and organizations in capacity building
- 3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treatiessigned by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	<b>Emerging Issues in IPR:</b> Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	<b>Basics of Patents:</b> Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	<b>Patent Rules:</b> Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08

	Procedure for Filing a Patent (National and International): Legislation and	
	Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing	
06	of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent	07
	Licensing, Patent Infringement	
	Patent databases: Important websites, Searching international databases	

### **Internal Assessment for 20 marks:**

#### Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

#### **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

### **Reference Books:**

- 1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
- 2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
- 3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
- **4.** Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
- **5.** Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7<sup>th</sup> Edition, Sweet & Maxwell
- 6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3<sup>rd</sup> Edition, WIPO
- 7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
- 8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
- **9.** M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
- **10.** Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
- 11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,

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- **12.** Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
- **13.** N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
- 14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
- 15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press.

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Course Code	Course Name	Credits
ILO 8028	Digital Business Management	03

- 1. To familiarize with digital business concept
- 2. To acquaint with E-commerce
- 3. To give insights into E-business and its strategies

**Outcomes:** The learner will be able to .....

- 1. Identify drivers of digital business
- 2. Illustrate various approaches and techniques for E-business and management
- 3. Prepare E-business plan

Module	Detailed content	Hours
1	Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)	09
2	<ul> <li>Overview of E-Commerce</li> <li>E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement</li> <li>B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals</li> <li>Other E-C models and applications, innovative EC System-From E- government and learning to C2C, mobile commerce and pervasive computing</li> <li>EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethicsand Societal impacts of EC</li> </ul>	06
3	<ul> <li>Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system</li> <li>Application Development: Building Digital business Applications and Infrastructure</li> </ul>	06

4	Managing E-Business-Managing Knowledge, Management skills for e-business, Managing Risks in e –businessSecurity Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private KeyCryptography, Digital Signatures, Digital Certificates, Security Protocols overPublic Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	E-Business Strategy-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy,         E-business strategy into Action, challenges and E-Transition         (Process of Digital Transformation)	04
6	Materializing e-business:From Idea to Realization-Business planpreparationCase Studies and presentations	08

## Assessment:

### **Internal Assessment for 20 marks:**

## Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

## **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

## **References:**

- 1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
- 2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
- 3. Digital Business and E-Commerce Management, 6<sup>th</sup> Ed, Dave Chaffey, Pearson, August 2014
- 4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
- 5. Digital Business Concepts and Strategy, Eloise Coupey, 2<sup>nd</sup> Edition, Pearson
- 6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
- 7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan

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- **8.** E-Governance-Challenges and Opportunities in : Proceedings in 2<sup>nd</sup> International Conference theory and practice of Electronic Governance
- 9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
- **10.** Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

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Course Code	Course Name	Credits
ILO8029	<b>Environmental Management</b>	03

- 1. Understand and identify environmental issues relevant to India and global concerns
- 2. Learn concepts of ecology
- 3. Familiarise environment related legislations

**Outcomes:** Learner will be able to...

- 1. Understand the concept of environmental management
- 2. Understand ecosystem and interdependence, food chain etc.
- 3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	
06	General overview of major legislations like Environment Protection Act, Air(P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

#### Assessment:

## **Internal Assessment for 20 marks:**

### Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

### **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of total six questions, each carrying 20 marks
- 2. Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4. Only Four questions need to be solved.

### **References:**

- 1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
- 2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
- 3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
- 4. Indian Standard Environmental Management Systems Requirements with Guidance For Use, Bureau Of Indian Standards, February 2005
- 5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
- 6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3<sup>rd</sup> Ed. Access Publishing.2015

Course Code	Course Name	Credits
ARL801	Laboratory based on IoT	01

- 1. To learn microcontroller programming using 8051 and Arduino Development Board.
- 2. To acquaint with interfacing of simple peripheral devices to a microcontroller.
- 3. To acquaint with exchange of data using wireless communication.
- 4. To familiarize with logging the data on cloud platform.

### Outcomes: Learner will able to...

- 1. Develop simple applications using microcontrollers 8051 and Arduino.
- 2. Interface simple peripheral devices to a Microcontroller.
- 3. Use microcontroller based embedded platforms in IoT.
- 4. Use wireless peripherals for exchange of data.
- 5. Setup cloud platform and log sensor data.

## List of Experiments:

- 1. Interfacing experiments using 8051 Trainer kit and interfacing modules
  - a. display (LCD/LED/Seven Segment)
  - b. Stepper / DC Motor
- 2. Introduction to Arduino platform and programming
- 3. Simple Applications using Arduino Development Board (Any two)
  - a. Simple LED Blinking using development board
  - b. Building IOT Smart Switch using IOT
  - c. Pulse Width Modulation
  - d. Analog to Digital / Digital to Analog Conversion
- 4. Interfacing Arduino with a Sensor (Any one): Temperature Sensor / PIR/ Ultrasonic sensor/ IR Sensor/ Flame Sensor/ MQ6 Sensor/ Humidity sensor/ Raindrop Sensor, magnetometers, cameras, accelerometers etc.
- 5. Interfacing Arduino with an Actuator (Any One): Motors / solenoids / Controllers etc.
- 6. Communication using Wireless Medium (Any One): WiFi / Bluetooth / Zigbee / RFID etc.
- 7. Setting up and Cloud Platform and logging Sensor Data on the platform.

## Assessment:

#### **Term Work**

Term work shall consist of the experiments as mentioned above. The distribution of marks for term work shall be as follows:

- 1. Laboratory work (Experiments): 20 marks
- 2. Attendance: 05 marks

## **End Semester Practical/Oral Examination:**

Pair of Internal and External Examiner should conduct practical examination followed by Oral.

Course Code	Course Name	Credits
ARL802	Product Design and Development	01

- 1. To familiarize concepts in PD&D for practical implementation
- 2. To acquaint with the applicability of PD&D in industrial applications

Outcomes: Learner will be able to...

- 1. Identify the need for developing products
- 2. Select suitable PD&D processes
- 3. apply the creativity & industrial design methods to design & develop the chosen product
- 4. Work collaboratively in a team to complete a PD&D project.
- 5. Effectively communicate the results of projects and other assignments both in a writtenand oral format.

#### Assignments:

Total 3 to 4 assignments have to be given.

Assignments III and IV are compulsory and shall be treated like mini-projects. Two more could becovered from the remaining as case studies.

### I. Based on Module No. 1 and 2.

- 1. Select any one consumer product, such as
  - a) a mobile
  - b) a laptop
  - c) a pencil sharpener
  - d) a table and chair
  - e) a stool
  - f) a bicycle
  - g) a pen
  - h) a storage device of any household items
  - i) a cupboard etc.... anything

Assume that you want to go for re-development of any one of the products.

How would you tackle by answering any 3 or 4 points that are given below?

- Q1. Howdo you identify the need for developing the product?
- Q2. What are the changes that you would like to incorporate?
- Q3. Would it be Engineering Design or Industrial design factors or both?
- Q4. What are the generic PD&D processes that you would like to adopt?
- Q5. Whatare the methods that you would adopt for Market research?
- Q6. If you would like to develop which design process you would like to adopt?

Q7. If you select descriptive design... then why? If you select prescriptive design... then why?

Q8.What are the steps that you would like to adopt while developing the product? University of Mumbai

#### II. Based on Module No. 3.

- 2. Select any one consumer product, such as
  - a) a mobile
  - b) a laptop
  - c) a pencil sharpener
  - d) a table and chair
  - e) a stool
  - f) a bicycle
  - g) a pen
  - h) a storage device of any household items
  - i) a cupboard etc.... anything

Assume that you want to go for re-development of any one of the above products. How would you tackle by

answering any 3 or 4 points that are given below?

Q1. How do you identify the customer needs for developing the product?

Q2. How do you ascertain/select the attributes that are to be tackled?

Q3. Would you like to go for Engineering Design factors or Industrial design factors or both?

Q4. How do you develop a correlation matrix?

Q5. How do you "Construct House of Quality"?

Q6. What are the generic PD&D processes that you would like to adopt in re-designing it using House of quality?

Q7. What are the methods that you would adopt for Market acceptance?

Q8. How do you document the entire design process?

### III. Based on Module No. 4.

- 3. Select any one consumer product, such as
  - a) a mobile

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- b) a laptop
- c) a pencil sharpener
- d) a table and chair
- e) a stool
- f) a bicycle
- g) a pen
- h) a storage device of any household items
- i) a cupboard etc.... anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the creativity method to design the chosen product using any one creativity methods? Develop the product and document the entire process by answering some of the questions as shown in I or II.

### IV. Based on Module No. 5.

- 4. Select any one consumer product, such as
  - a) a mobile
  - b) a laptop
  - c) a pencil sharpener
  - d) a table and chair
  - e) a stool
  - f) a bicycle
  - g) a pen
  - h) a storage device of any household items
  - i) a cupboard etc.... anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the principles of Industrial Design methods to design the chosen product? Develop the product and document the entire process by answering some of the questions as shown in I or II.

#### V. Based on Module No. 6.

- 5. Select any one consumer product, such as
  - a) a mobile
  - b) a laptop

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- c) a pencil sharpener
- d) a table and chair
- e) a stool
- f) a bicycle
- g) a pen
- h) a storage device of any household items
- i) a cupboard etc.... anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the principles of DFMA to design the chosen product? Develop the exploded view of the product and document the entire process by answering some of the questions as shown in Ior II.

## The distribution of marks for term work shall be as follows:

Assignments/Case studies:10 marks. Mini

Project:10 marks.

Attendance: 05 Marks.

# **End Semester Practical/Oral examination**

- 1. Pair of Internal and External Examiner should conduct practical/viva based on contents
- 2. Distribution of marks for practical/viva examination shall be as follows:
  - a) Practical performance .....15 marks
  - b) Oral .....**10** marks

Evaluation of practical examination to be done based on the practical performed.

Students work along with evaluation reports to be preserved till the next examination.

## Text/Reference Books:

- 1. Baker, M. & Hart S. (2007), Product Strategy and Management, (2<sup>nd</sup>. Ed.) Edinburgh: Pearson Education.
- 2. Ulrich, K. & Eppinger, S. (2012), Product Design and Development. (5<sup>th</sup>. Ed.) Los Angeles: McGraw Hill Education.
- 3. Yousef Haik, T. M. M. Shahin (2010), Engineering Design Process, (2<sup>nd</sup>. Ed. Reprint), Cengage Learning, ISBN 0495668141.
- 4. Kevin Otto, Kristin Wood (2004), Product Design, (Indian Reprint), Pearson Education, ISBN 9788177588217.

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Course Code	Course Name	Credits
ARP801	Major Project II	12

The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification to successful completion of the project by implementing the solution.

#### **Outcomes: Learner will able to**

- 1 Students will be able to implement solutions for the selected problem by applying technical and professional skills.
- 2 Students will be able to analyze impact of solutions in societal and environmental context for sustainable development.
- 3 Students will be able to collaborate best practices along with effective use of moderntools.
- 4 Students will be able to develop proficiency in oral and written communication with effective leadership and teamwork.
- 5 Students will be able to nurture professional and ethical behavior.
- 6 Students will be able to gain expertise that helps in building lifelong learningexperience.

#### **Guidelines:**

1. Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.

#### 2. Project Report Format:

At the end of semester, each group need to prepare a project report as per the guidelines issued by the University of Mumbai. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and userManuals.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey/ Existing system
- o Limitation Existing system or research gap
- Problem Statement and Objective

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- Proposed System
  - o Analysis/Framework/ Algorithm
  - Design details
  - Methodology (your approach to solve the problem) Proposed System
- Experimental Set up
  - o Details of Database or details about input to systems or selected data
  - Performance Evaluation Parameters (for Validation)
  - Software and Hardware Set up
- $\circ$  Results and Discussion
- Conclusion and Future Work
- References
- Appendix List of Publications or certificates

#### Desirable

- Students should be encouraged
  - to participate n various project competition.
  - o to write minimum one technical paper & publish in good journal.
  - to participate in national / international conference.

## 3. Term Work:

Distribution of marks for term work shall be done based on following:

- a. Weekly Log Report
- b. Completeness of the project and Project Work Contribution
- c. Project Report (Black Book) (both side print)
- d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

## 4. Oral & Practical:

Oral & Practical examination (Final Project Evaluation) of Project 2 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.

## Suggested quality evaluation parameters are as following:

- 1. Relevance to the specialization / industrial trends
- 2. Modern tools used
- 3. Innovation
- 4. Quality of work and completeness of the project
- 5. Validation of results
- 6. Impact and business value
- 7. Quality of written and oral presentation
- 8. Individual as well as team work

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