VIVEKANAND EDUCATION SOCIETY'S
Institute of Technology

(An Autonomous Institute Affiliated to University of Mumbai, Approved by A.I.C.T.E & Recognized by Govt. of Maharashtra)

Department of Automation and Robotics

Program Structure for Final Year B.E Automation and Robotics

(With Effect from 2025-2026)

Scheme for Semester –VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract.Tut.	Theory	Pract.	Tut.	Total
ARC701	Process Automation	3	--	3	--	--	3
ARC702	Instrumentation Project Documentation and Execution	3	--	3	--	--	3
ARC703	Machine Vision	3	-	3	-	-	3
ARDOC701X	Department Optional Course–3	3	--	3	--	--	3
IOC701X	Institute Optional Course–1	3	--	3	--	--	3
ARL701	Process Automation - Lab	--	2		1		1
ARL702	Instrumentation Project Documentation and Execution -Lab	--	2		1		1
ARL701X	Department Optional Course-3 -Lab	--	2		1		1
ARP701	Major Project-I	--	6#	--	3	--	3
Total		**15**	**12**	**15**	**6**	**--**	**21**

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Department of Automation and Robotics

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ARC701	Process Automation	20	20	60	2	--	--	100
ARC702	Instrumentation Project Documentation and Execution	20	20	60	2	--	--	100
ARC703	Machine Vision	20	20	60	2	--	--	100
ARDOC701X	Department Optional Course– 3	20	20	60	2	--	--	100
IOC701X	Institute Optional Course	20	20	60	2	--	--	100
ARL701	Process Automation - Lab	--	--	--	--	25	25	50
ARL702	Instrumentation Project Documentation and Execution- Lab	- -	- --	- -	- -	25	25	50
ARL701X	Department Optional Course -3 – Lab	--	--	--	--	25	25	50
ARP701	Major Project-I	--	--	--	--	50	50	100
	Total	100	100	300	--	125	125	750

 # Indicates the workload of Learner (Not Faculty), for Major Project

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Department Optional Course – 3 (Semester- VII)

ARDOC 7011	Advanced Embedded Systems	
ARDOC 7012	Advanced Biomedical Instrumentation	Lab work
ARDOC 7013	Internet of Things	
ARDOC 7014	Power Plant Automation	

Institute Optional Course – 1 (Semester- VII)

IOC7011	Product Lifecycle Management	IOC7016	Cyber Security and Laws
IOC7012	Reliability Engineering	IOC7017	Disaster Management and Mitigation Measures
IOC7013	Management Information System	IOC7018	Energy Audit and Management
IOC7014	Design of Experiments	IOC7019	Development Engineering
IOC7015	Operation Research		

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC701	**Process Automation**	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Se Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC701	Process Automation	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ARC701	Process Automation	3

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Course Objectives:	
1	To give the students fundamentals of automation and various automation systems used in industry such as PLC, SCADA, and DCS.
2	To impart the knowledge about the architecture, working of PLC, SCADA and DCS
3	To make the students capable to apply knowledge to identify hardware and software requirements of PLC, SCADA and DCS
4	To give the students a comprehension of the aspects related to Safety Instrumented system (SIS).

Course Outcomes:	
The students will be able to	
1.	Describe automation, need, importance and applications in industry.
2.	Discuss the importance of communication protocols in automation
3.	Identify components of PLC, and develop PLC ladder using instructions of PLC and design PLC based application by proper selection and sizing criteria.
4.	Describe SCADA architecture, communication in SCADA and develop any application based on SCADA along with GUI using SCADA software.
5.	Explain evolution and architecture of DCS, hierarchical control in DCS
6.	Explain database and alarm management system

Module	Detailed Content	No. of Hours
1	Automation, Need for automation and its importance, Types of automation, Process and factory automation.Automation applications, Industry 4.0 automation systems architecture. Automation hierarchy – large control system hierarchy, data quantity & quality and hierarchical controls.	**4**

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2	**Communication Protocols** Elements of communication system, Simplex & Duplex communication modes-OSI reference model, TCP/IP model, Transmission media, UTP-STP cable, coaxial cable, N/W components: Repeaters, bridge, hub, switch, router, gateways, topology, evolution of communication protocols, RS232, RS422, EIA485, HART, Profibus- DP, Profibus-PA, foundation fieldbus, communication protocols: AS-i, Foundation Fieldbus H1-HART Profibus-PA, Profibus-DP, Ethernet, TCP/IP .	7
3	**Programmable Logic Controller Hardware** Evolution of PLC, PLC Architecture,Types & Specifications. Safety PLC I/O modules, local and remote I/O expansion, special purpose modules, wiring diagrams of different I/O modules, communication modules, Memory & addressing- memory organization, I/O addressing, hardware to software interface. **Software** Introduction to PLCProgramming, programming devices, IEC standard PLC programming languages, LD programming- basic LD instructions, PLC Timers and Counters: Types and examples, data transfer & program control instructions, advanced PLC instructions, PID Control using PLC. **Case study:** PLC selection and configuration for any one process application**.**	10
4	**Supervisory Control and Data Acquisition (SCADA)** SCADA introduction, brief history of SCADA, elements of SCADA. Features of SCADA, Protocol structure, Specifications of SCADA, SCADA as a real time system, Communications in SCADA- types & methods used, components. SCADA Development for any one typical application Programming for GUI development using SCADA software	6
5	**Distributed Control System (DCS)** Introduction to DCS, generic architecture of DCS (hardware and software) -Controller, Input and output modules, Communication module, data highway, local I/O bus, Workstations. Supervisory computer functions, DCS and Supervisory computer displays- group,	8

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	detailed, trend and graphica. DCS System integration with PLCs computer: HMI, Man machine interface sequencing, Supervisory control, and integration with PLC, personal computers and direct I/O, serial linkages, network linkages, link between networks. Introduction to DCS Programming, Function Block Diagram method for DCS programming.	
6	**Database and Alarm Management, MES, ERP** Introduction to Database management, alarm management system, Manufacturing Execution System, Enterprise Resource Planning, Integration with enterprise system.	**4**
	Total	**39**

Text Books:	
1	Samuel M. Herb, "Understanding Distributed Processor Systems for Control", ISA Publication.
2	Thomas Hughes, "Programmable Logic Controller", ISA Publication.
3	Stuart A. Boyer, "SCADA supervisory control and data acquisition", ISA Publication.
4	Gruhn and Cheddie, "Safety Shutdown Systems" – ISA, 1998.

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References:	
1.	Poppovik Bhatkar, "Distributed Computer Control for Industrial Automation", Dekkar Publication
2.	S.K. Singh, "Computer Aided Process Control", Prentice Hall of India.
3.	Krishna Kant, "Computer Based Process Control", Prentice Hall of India
4.	N.E. Battikha, "The Management of Control System: Justification and Technical Auditing", ISA.
5.	Gary Dunning, "Introduction to Programmable Logic controller", Thomas Learning, edition, 2001.
6.	John. W. Webb, Ronald A Reis, "Programmable Logic Controllers – Principles and Applications", 3rd edition, Prentice Hall Inc., New Jersey, 1995.
7.	Bela G. Liptak "Instrument engineer's handbook- Process control" Chilton book company- 3rd edition.
8.	Curtis Johnson, "Process Control Instrumentation Technology", PHI/Pearson Education2002.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks

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5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC702	Instrumentation Project Documentation and Execution	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Se Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC702	Instrumentation Project Documentation and Execution	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ARC702	Instrumentation Project Documentation and Execution	3

Course Objectives:	
1.	To provide knowledge of Instrumentation Project & Detailed Engineering techniques in the EPC Consultancy.
2.	To make the students capable of executing Project Deliverables and Engineering activities of

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	Project Documentation.

Course Outcomes:
The students will be able to

1.	Interpret types of projects and execute it by knowing the relationship between customer, designer and constructor.
2.	Apply standards in instrumentation projects and prepare basic engineering documents.
3.	Design engineering documents such as loop diagram, hook-up, JB schedule.
4.	Develop and test system integration.
5.	Schedule and evaluate activities like procurement, commissioning, and installation.
6.	Support and evaluate documentation software packages used in industry.

Module	Detailed Content	No. of Hours
1.	**The Project and Project Team:** Introduction, Types of projects, structure, Project scope, Project flow and deliverables, Need and techniques used for Project Planning and Scheduling **The Project Team:** Customer, designer and constructor; Responsibility matrix.	05
2.	**Project Documentation Standards**: Introduction to ISA (ISA 5.1, 5.2, 5.4, ISA 20 etc), NEMA, ANSI standards. **Project Engineering Documents:** Preliminary Engineering Documents: PFD, P&ID (ISA S-5.1), Cause and effect diagram. Front End Engineering and Design (FEED) documents: Instrument index sheet, I/O schedule, Instrument specification sheets (ISA S-20) for pressure, temperature, flow and level instruments.	10
3.	**Detailed Engineering Design:** Instrument Loop wiring diagrams (ISA S-5.4), (ISA S-5.2), Instrument Hook up, BOM, Instrument Location Plan **Cable Engineering:** Class of conductors, Types, Specification, Selection, Cable schemes, Cable trays. Earthing and Grounding for General and power Signals. Power Distribution diagram, Earthing Diagram, Cable and Junction box schedule	07

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4.	**Construction activities:** Site conditions and planning, Installation activities/ procedures and documents required. Types of operating Stations, Control system specifications, Control system graphics (ISA S5.5), databases, I/O allocation and configuration. **System Integration:** HMI specification Development, System Architecture Design: Network single line diagram generation.	07
5.	**Procurement activities**: Pre-Qualification Evaluation of Vendor, Vendor registration, Tendering and bidding process and required documents, Bid evaluation, Purchase orders. **Commissioning and Testing Activities:** Panel testing Procedure and its documentation. Factory Acceptance Test (FAT), Customer Acceptance Test (CAT), Site inspection and testing (SAT), Calibration records, Test and inspection reports. Cold Commissioning and hot commissioning, punch list.	06
6.	**Overview of project documentation tools:** Introduction of various tools for project engineering documentation and project planning /scheduling.	04
	Total	**39**

Text Books:	
1.	Andrew &Williams ,*"Applied instrumentation in process industries"*, Gulf Publishing.
2.	Peter Watermeyer*, "Hand book for Process Plant Project Engineers",* Professional Engineering Publishing, 2002.
3.	John Bacon, *"Management systems"*, (ISA)
4.	B.G. Liptak, *"Hand book- Process control Instrument Engineers"*.
5.	Michael D. Whitt ,*"Successful Instrumentation & Control Systems Design*", ISA
6.	Pradeep Pai , *"Project Management",* Pearson Education.
7.	B.C. Punmia and K.K. Khandelwal, *"Project Planning and Control with PERT and CPM"*, Laxmi Publications Private Limited.

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References:	
1.	Harold Kerzner, Van Nostrand, *"Project Management A System Approach to Planning, Scheduling and Controlling"*, Reinhold Publishing, 2001.
2.	ISA Manual,*"Instrument Installation and Project Management"*,2000.
3.	ANSI-ISA,*"Instrumentation Symbols and Identification"*, 1992.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

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End Semester Theory Examination:		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC703	Machine Vision	3	-	3	-	-	3

Course code	Course Name	Examination Scheme				Term Work	Pract & oral	Total
		Theory						
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
ARC703	Machine Vision	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ARC703	Machine Vision	3

Course Objectives:	
1.	Understand image formation and the role human visual system plays in perception of grey and colour image data.
2.	Describe various applications of image processing in various sectors like medical, defence, etc.
3.	Learn the signal processing algorithms and techniques in image enhancement and image restoration.
4.	Apply various image processing techniques to solve real world problems.

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Course Outcomes:

The students will be able to

1.	Understand image formation and the role the human visual system plays in perception of gray and colour image data.
2.	Describe various applications of image processing in various sectors like medical, defence, etc.
3.	Learn the signal processing algorithms and techniques in image enhancement and image restoration.
4.	Apply various image processing techniques to solve real world problems.

Module	Detailed Content	No. of Hours
1.	**Introduction and Digital Image Fundamentals:** Digital Image Fundamentals, Human visual system, Image as a 2D data, Image representation – Gray scale and Color images, image sampling and quantization,Basic Relationship between Pixels	7
2.	**Image enhancement in Spatial domain:** Basic gray level Transformations, Histogram Processing Techniques, Histogram equalization, Histogram Matching, Spatial Filtering, Low pass filtering, High pass filtering,	7
3.	**Filtering in the Frequency Domain:** Introduction to the Fourier transform and frequency domain concepts, Extension to functions of two variables, low pass filter, high pass filter, Laplace transformation, Image Smoothing, Image Sharpening, Homo-morphic filtering	7
4.	**Colour Image Processing** Colour Fundamentals, Colour Models, Pseudo colour image processing,Color Transformations,SMoothing and Sharpening,Image Segmentation based on Colour	6
5.	**Morphological Image Processing:** Erosion, dilation, opening, closing, Basic Morphological Algorithms: hole filling, connected components, thinning, skeletons	6
6.	**Image Segmentation:** Point Line and Edge Detection, Thresholding, Region-Based Segmentation,Segmentation Using Morphological Watersheds	6
	Total	**39**

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Text Books:	
1.	Digital Image Processing, 3rd Edition, by Rafael C Gonzalez and Richard E Woods. Publisher: Pearson Education.

References:	
1.	Milan Sonka, Vaclav Hlavav, Roger Boyle, ―Image Processing, Analysis and Machine Vision‖, 2nd ed., Thomson Learning, 2001
2.	Pratt W.K, ―Digital Image Processing‖, 3rd ed., John Wiley & Sons, 2007
3.	Digital Image Processing Using Matlab, Rafel C. Gonzalez and Richard E. Woods, Pearson Education
4.	Fundamentals of Digital Image Processing by Anil K Jain, PHI

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks

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7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARDOC7011	Advanced Embedded System	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
ARDOC7011	Advanced Embedded System	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ARDOC7011	Advanced Embedded System	3

Course Prerequisite:	Microcontrollers, Microprocessor, C-Programming

Course Objectives:	
1	Study the architecture of ARM series microprocessor and its need in applications
2	Learn architecture and programming for ARM Cortex-M series Microcontroller.
3	Application of RTOS for embedded programming

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Course Outcomes:	
After successful completion of the course student will be able to	
1.	Understand the characteristics and technologies of embedded systems.
2.	Describe different program modelling concepts
3.	Describe the ARM microprocessor architecture and its features.
4.	Understand the functions and programming of memory peripherals on advanced ARM.
5.	Study the concepts of Real time operating systems and write programs
6.	Study the concepts of Task resource sharing

Module	Detailed Content	No. of Hours
1	**Introduction to ARM Cortex** ● History of ARM processors and Series ● ARM Architecture ,Addressing Modes ● Instructions Overview Arithmetic,Logic ,Branch, and Call Instructions ● ARM Memory Map , Memory Access, and Stack ● ARM Pipeline ● Development and debugging Tools for Embedded Systems	8
2	**Cortex M4 Microcontrollers & Peripherals:STM32F401CC** ● Cortex M4-based controller architecture ● ARM Cortex M4 Core, Interconnect Matrix in ARM Cortex M4 Microcontroller ● Reset and Clock Control, Clock Recovery System, Power Control ● Memory mapping,	7
3	**Cortex M4 Microcontrollers & Peripherals:STM32F401CC** ● Cortex M4 Peripherals – RCC, GPIO, Timer, System timer, PWM ● Cortex M4 Peripherals -- ADC,RTC ● DMA Interfacing	6
4	**Advanced Cortex:** Basics of cache,Memory Hierarchy,Direct Mapped and Set Associative cache	6

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	Cache policy Memory Management Unit ,Virtual Memory,Translation Lookaside Buffer,address translation,Memory Attributes	
5	**RTOS basics**, Timing Constraints, classification and modelling, Task Instance ,Deadlines ,Types of Real Time OS,Types of Task Scheduling and its comparisons	6
6	**Task Operations**, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use Resource Sharing between Tasks Priority Inversion,Priority Inheritance Protocol	6
	Total	**39**

Text Books:	
1	ARM assembly Language programming and Architecture Muhammed Ali Mazidi ,Sarmad Naimi, Sepehr Naimi and Shuejn Chen by Microdigital Ed
2	Beginning STM32 Warren Gay apress Publication
3	Shibu K.V," Introduction to Embedded Systems", Mc Graw Hill, 2nd edition.
4	Frank Vahid, and Tony Givargis, "Embedded System Design: A unified Hardware/Software Introduction", Wiley Publication.
5	Raj Kamal," Embedded Systems Architecture, Programming and design",Tata MCgraw-Hill Publication.
6	Dr. K.V.K.K. Prasad, "Embedded Real Time Systems: Concepts, Design & Programming",Dreamtech Publication.

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7	Joseph Yiu, "The Definitive Guide to the ARM Cortex-M", Newness, ELSEVIER.
8	ARM Systems Developer's Guides- – A. N. Sloss, D. Symes, C. Wright, Elsevier 2008.
9	Embedded Microcomputer Systems, Real Time Interfacing – J.W. Valvano, Cole, 1999.

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Department of Automation and Robotics

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARDOC7012	Advanced Biomedical Instrumentation	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Term Work	Pract & oral	Total	
		Internal Assessment		End Se Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
ARDOC7012	Advanced Biomedical Instrumentation	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ARDOC7012	Advanced Biomedical Instrumentation	3

Course Objectives:	
1	To make students understand the working principle and application of various Advanced Biomedical Instruments used in Biomedical field

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2	To make students understand the working and applications of imaging techniques in depth.

Course Outcomes:
The students will be able to

1.	Identify various Bio-potential with their specifications, design signal conditioning for the same and perform their measurements.
2.	Discuss various prosthetic devices and to identify their parameters for proper operation.
3.	Explain the principle and working of various patient monitoring and telemetry systems.
4.	Distinguish between the various medical imaging techniques based on the principles and concepts involved in them.
5.	Discuss the applications of fibre optics and lasers in Biomedical.
6.	Describe the significance of radiation, electrical and fire safety in biomedical measurement.

Module	Detailed Content	No. of Hours
1	**Introduction to Bio-potential Measurement:** Measurement of membrane potentials, Bio-potential amplifiers, ECG, EEG and EMG measurements, Design of ECG, EEG and EMG signal conditioning circuit, EMG Quantification circuit.	06
2	**Prosthetic devices:** Pacemakers – types and constructional details, Design of asynchronous pacemaker using op-amp and 555 timer, Implantable defibrillators and cardiovertors, Cochlear implants – principle, working and construction, Retinal Implants - principle, working and construction, Wearable Artificial Kidney,	08

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	Functional electrical stimulator (FES) for neural and muscular stimulation.		
3	**Patient monitoring system:** Bedside monitor, Central Nurse station, Telemetry system and Telemedicine.		**03**
4	**Advanced Medical Imaging:** Computed Tomography (CT) - Details of Acquisition, Digital image reconstruction and display, Magnetic resonance imaging (MRI) – image acquisition and reconstruction techniques, Nuclear Imaging – nuclear radiation detectors, rectilinear scanner, Gamma camera, positron emission tomography (PET), single photon emission computed tomography (SPECT) and its applications.		**10**
5	**Fibre optics and Lasers for Biomedical applications:** Optical Sources and Detectors, LASER diodes, Photo detectors – photodiodes, phototransistors, LDRs. Introduction to Fiber Couplers and Connectors, Lasers and its types, properties of lasers and interaction with tissues, Basic endoscopy and laparoscopy system.		**08**
6	**Radiation, Electrical and Fire Safety:** Radiation safety, Safety precautions, Hazardous effects of radiation, allowed levels of radiation, Electrical safety, sources of shock, macro & micro shocks, monitoring and interrupting the operation from leakage current, Elements of fire, causes of fire & fire protection.		**04**
	Total		**39**

Text Books:	
1	Leslie Cromwell, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education, 1980.

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2	John G. Webster, "Medical Instrumentation", John Wiley and Sons, 4th edition, 2010.
3	R. S. Khandpur, "Biomedical Instrumentation", TMH, 2004
4	Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", PHI/Pearson Education, 4th edition, 2001.

References:	
1	Richard Aston, "Principles of Biomedical Instrumentation and Instruments", PH, 1991.
2	John E Hall, Gyton's Medical Physiology, 12th edition, 2011
3	L. E. Baker L. A. Geddes, "Principles of Applied Biomedical Instrumentation", John Wiley and Sons, 3rd Edition, 1991.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks

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5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARDOC7013	Internet Of Things	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)				
		Mid Test (MT)	CA *						
ARDOC7013	Internet Of Things	20	20	60	2		--	--	100

Course Code:	Course Title	Credit
ARDOC7013	Internet Of Things	3

Course Objectives:	
1	To impart knowledge about fundamentals of IoT
2	To describe data and knowledge management and use of devices in IoT technology.
3	To give knowledge of IoT architecture and Integration of embedded devices with IoT

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4	To explain the concept of IIoT.
5	To impart knowledge about designing of industrial internet systems.
6	To describe overview of Android/ IOS app development tools and Internet of Everything

Course Outcomes:

The students will be able to

1.	Describe the evolution of IoT
2.	Describe the IoT networking components, addressing strategies and protocols in IoT.
3.	Explain various Cloud service and ANalytics and Integrate into IoT systems
4.	Classify the various threats and security related to IoT
5.	To design and develop sophisticated IOT system

Module	Detailed Content	No. of Hours
1	**Introduction to Internet of Things: An Overview** Definition and characteristics of IoT, IBM IoT conceptual framework Software & Hardware component for IoT Modified OSI Model for the IoT/M2M Systems IoT vs M2M Basic Network Terminologies Switches,Bridges,Routers	4
2	**Physical Design of loT Communication Protocols loT Communication Models** Discuss Basics,Connection Protocol ,Power,Range Wired Ethernet,USB Wireless Wifi,802.15.4-LR-WPAN,Zigbee,Bluetooth LORA technology 2G/3G/ 4G - Mobile Communication Introduction to IPv4,IPv6,6LOWPAN	8
3	**I**oT Protocols Internet connectivity Features, Connection protocol and Application TCP, UDP Application Layer OSI Layer ,Features,Quality of Standard Policy,Application for HTTP,COAP,,MQTT Data Representation Formats JSON,XML loT Communication APIs REST-based Communication API	9

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	WebSocket-based Communication APIs	
4	Basics of Cloud Computing ,Virtualisation, Cloud Deployment Models Analytics Architecture Reference Model loT Levels & Deployment Templates Need of loT Systems Management ,Basics of SNMP	6
5	Vulnerabilities, Security requirements and Threat analysis Security Tomography, Layered Attacker Model,Identity Management and Establishment	6
6	loT Design Methodology Case Studies using IoT design Methodology	6
	Total	39

Text Books:	
1	Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014.
2	INTERNET OF THINGS Architecture and Design Principles b y RajKamal

References:	
1	Francis DaCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
2	Wimer Hazenberg, Menno Huisman and Sara Cordoba Rubino, "Meta Products: Building the Internet of Things", BIS publishers.
3	Cuno Pfister , "Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud (Make: Projects)", 1st Edition, O'REILLY publications.
4	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
5	Cristina Alcaraz, Pablo Najera, Javier Lopez, Rodrigo Roman, "Wireless Sensor Networks and the Internet of Things."
Web sites:	
1	www.atmel.com
2	www.microchip.corn
3	www.nxp.com

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARDOC7014	Power Plant Automation	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARDOC7014	Power Plant Automation	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ARDOC7014	Power Plant Automation	3

Course Objectives:	
1	To create awareness of energy resources and its scenario in India and worldwide.
2	To study the concept of power generation using various resources.
3	To study the role of Instrumentation in power plants

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4	To study and compare various power plants for optimal performance
5	To acquire students the knowledge about hazards and safety in handling power plants

Course Outcomes:

The students will be able to

1.	Classify the energy generation resources.
2.	Illustrate operation and control of thermal power plant equipment
3.	Select the sites for hydroelectric power plants and explain its operation
4.	Explain the power generation and control of nuclear power plant.
5.	Describe the non-conventional energy resources
6.	Compare different types of power plants

Module	Detailed Content	No. of Hours
1	**Introduction:** Energy sources, their availability, worldwide energy production, energy scenario of India. Introduction to Power generation, load curve, load factor. Classification of energy generation resources	4
2	**Thermal Power Plant**- Method of power generation, layout and energy conversion process. Types of Turbines & their control. Boilers and their control. Types of Generators and their control, Types of Pumps and Fans, Material handling system, study of all loops-water, steam, fuel etc.Schematics of Gas turbine and Diesel power plant.	10
3	**Hydroelectric Power Plant**- Site selection, Estimation electric power to be developed, classification of Hydro power plants Types of Turbines for hydroelectric power plant,	6

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	pumped storage plants, storage reservoir plants	
4	**Nuclear Power Plant –** Concept of energy generation from nuclear fission,control of chain reaction, schematics of Nuclear power plant, types of reactors, reactor control, safety measures.	6
5	**Non-conventional Energy Resources –** **Wind Energy:** Power in wind, wind power conversion, aerodynamics of wind turbine, types of wind turbine and their modes of operation, power control of wind turbines and detection of failure, Betz limit, Pitch & Yaw control, connection of wind mill on power grid, applications of wind energy, safety. **Solar Energy:** Solar resource, solar energy conversion systems. Solar PV technology: Block diagram of PV system, Detection of failure and performance monitoring of PV cell in the array of cells, connection of solar power on power grid, advantages and limitations. **Solar thermal energy system**: Principle, solar collector and its types, solar concentrator and its types, safety.	9
6	**Comparison of different types of power plant**: On the basis of Performance, efficiency, site selection, Economics-capital and running, safety. Introduction to Hybrid Power Generation concept. Introduction to Modern Biomass, Bio-fuels, Geothermal energy, Tidal energy and Ocean thermal energy.	4
	Total	39

The Industrial visit is recommended for understanding of different process loops and functioning of the industry.

	Text Books:
1	P. K. Nag, Power plant engineering, Fourth edition (2017), McGraw Hill Education
2	K. Krishnaswamy, M. Ponni Bala, Power Plant Instrumentation, Second edition (2013), PHI
3	R. K. Rajput, A Textbook of Power Plant Engineering,Fifth edition (2016), Laxmi Publications.

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	References:
1	S.C.Arora, A.V. Domkundwar, Power Plant Engg.,(2013), Dhanpat Rai & Co.
2	B. H. Khan, Non-conventional energy resources, McGraw Hill, New Delhi
3	Chetan Singh Solanki, Renewable energy Technology, Prentice Hall Publication.
4	S. P. Sukhatme, Solar Energy, Tata McGraw Hill, New Delhi
5	G. D. Rai, Nonconventional energy sources, Khanna Publication
6	Dickinson & Cheremision off, Solar Energy Technology vol I & II
7	Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, Wind Energy Handbook (2001), John Wiley & Sons, ISBN: 0471489972.
8	James Manwell, J. F. Manwell, J. G. McGowan, Wind Energy Explained: Theory, Design and Application (2002), John Wiley and Sons Ltd, ISBN: 0471499722
9	Z. Lubosny, Wind Turbine Operation in Electric Power Systems (2003), Springer-Verlag New York, Inc; ISBN: 354040340X
10	G.F. Gilman, Boiler Control Systems Engineering, 2005, ISA Publication.

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4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7011	Product Life Cycle Management	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
IOC7011	Product Life Cycle Management	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7011	Product Life Cycle Management	3

Course Objectives:	
1	To familiarize the Learner with the need, benefits, and components of PLM
2	To acquaint Learner with Product Data Management & PLM strategies
3	To give insights into new product development program and guidelines for designing and developing a product

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4	To familiarize the Learner with Virtual Product Development, Design for environments, Life cycle assessment.

Course Outcomes:

The students 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.
4.	Acquire knowledge in applying virtual product development tools and design for the environment.

Module		Detailed Content	No. of Hours
1		**Introduction to Product Lifecycle Management (PLM)**	8
	1.1	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, spread of PLM, Focus and Application	
	1.2	PLM Strategies: Industrial strategies, Strategy elements, Developing PLM Vision and PLM Strategy, Change management for PLM	
2		**Product Design**	10
	2.1	Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model,	
	2.2	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 Variant Management,	
	2.3	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	

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3		**Product Data Management (PDM)**	**5**
	3.1	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system	
	3.2	Financial justification of PDM, barriers to PDM implementation	
4		**From sustainable Development to design for environmen**t	**6**
	4.1	Sustainable Development, Key factors in sustainable Development, Design for Environment	
	4.2	The Environment driving PLM- External Drivers: scale, Complexity, cycle times, globalization, regulations, Internal Drivers- Productivity innovation, collaboration, quality. Boardroom Driver-IT Value Map: income, revenue, costs. Comparing lean manufacturing, ERP, CRM and PLM	
5		**Life Cycle Assessment and Life Cycle Cost Analysis**	**6**
	5.1	Premises, Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment.	
	5.2	Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	
6		**Virtual Product Development Tool**	**4**
	6.1	Introduction VPD, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	
		Total	**39**

Text Books:	
1	John Stark, —Product Lifecycle Management: Paradigm for 21st Century Product Realization, 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

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3	Saaksvuori Antti, Immonen Anselmie, ―Product Life Cycle Management, Springer, Dreamtech, ISBN: 3540257314
4	Michael Grieve, ―Product Lifecycle Management: Driving the next generation of lean thinking‖, Tata McGraw Hill, 2006, ISBN: 0070636265

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7012	Reliability Engineering (Abbreviated as RE)	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory			Term Work	Pract & oral	Total	
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
IOC7012	Reliability Engineering (Abbreviated as RE)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7012	Reliability Engineering (Abbreviated as RE)	3

Course Objectives:	
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

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4	To understand the various aspects of Maintainability, Availability and FMEA procedure

Course Outcomes:	
The students 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

Module	Detailed Content	No. of Hours
1	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Bayes Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.	8
2	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, BathTub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time to Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, linearly increasing, Time	8
3	**System Reliability :** System Configurations: Series, parallel, mixed configuration, k out of n	5
4	**Reliability Improvement** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	8
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.	5

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6	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	**5**
	Total	**39**

	Reference Books:
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. Murray R. Spiegel, ―Probability and Statistics‖, Tata McGraw-Hill Publishing Co. Ltd

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(An Autonomous Institute Affiliated to University of Mumbai, Approved by A.I.C.T.E & Recognized by Govt. of Maharashtra)

Department of Automation and Robotics

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
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Department of Automation and Robotics

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7013	Management Information System	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Se Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
IOC7013	Management Information System	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7013	Management Information System	3

Course Objectives:	
1	To discuss the roles played by information technology in today's business.
2	To understand the Intelligent Techniques for Data Analytics.
3	To determine ethical and privacy issues in management systems.
4	To understand the requirements for various Business Operations

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5	To define various technologies on which information systems are built
6	To determine the types of systems used for enterprise-wide knowledge management and the way they provide value for businesses.

Course Outcomes:	
The students will be able to	
1.	The impact of information systems on an organization's growth.
2.	The principal tools and technologies for accessing information from databases to improve business performance and decision making.
3.	The ethical frameworks and security concerns in information systems.
4.	The various business models used for social computing.
5.	IT infrastructure and its components and its current trends
6.	Various enterprise-wide knowledge management systems and its functionalities.

Module	Detailed Content	No. of Hours
1	**Introduction to Information Systems (IS):**	4
	Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	
2	**Database and Business Intelligence:**	8
	Database Approach ,Big Data,Data warehouse and Data Marts, Managing Data resources, establishing an information policy,ensuring data quality. **Business intelligence (BI)**:Decision Making Process,BI for Data analytics and Presenting Results	
3	**Ethical and Social Issues in Information Systems:**	6
	Ethical issues and Privacy, Information Security. Threat to IS, and Security Controls	
4	**Social Computing (SC):**	7
	SC in business-shopping, Marketing, Operational and Analytical CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	

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5	**Emerging Technologies:**		7
	The Emerging Mobile Digital Platform: Consumerization of IT and BYOD (Bring Your Own Device), Grid Computing, Virtualization, Cloud Computing, Green Computing, High- Performance and Power-Saving Processors, Autonomic Computing Contemporary Software Platform Trends: Web Services and Service- Oriented Architecture, Software Outsourcing and Cloud Services Management Issues: Dealing with Platform and Infrastructure Change Management and Governance		
6	**Information System within Organization:**		7
	Knowledge management System, Knowledge management value chain, Decision Support System, Transaction Processing Systems, ERP and ERP support of Business Process.		
		Total	39

Text Books:	
1	Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2	K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 13th Ed. © Pearson Education Limited 2014

References:	
1	MIS: Management Perspective, D.P. Goyal, Vikas Publishing House Pvt. Ltd, 4th Edition.
2	D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7014	Design of Experiments (Abbreviated as DoE)	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Term Work	Pract & oral	Total	
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
IOC7014	Design of Experiments (Abbreviated as DoE)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7014	Design of Experiments (Abbreviated as DoE)	3

Course Objectives:	
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

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Course Outcomes:	
The students 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

Module	Detailed Content	No. of Hours
1	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	**6**
2	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	**8**
3	**Two-Level Factorial Designs:** The 2^2 Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split- Plot Designs.	**7**
4	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	**7**
5	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	**7**
6	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	**4**
	Total	**39**

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	Reference Books :
1	Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2	D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3	George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4	W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5	Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6	Philip J Ross, ―Taguchi Technique for Quality Engineering, McGraw Hill.
7	Madhav S Phadake, ―Quality Engineering using Robust Design, Prentice Hall.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7015	Operation Research (abbreviated as OR)	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
IOC7015	Operation Research (abbreviated as OR)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7015	Operation Research (abbreviated as OR)	3

Course Objectives:	
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.

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Course Outcomes:

The students will be able to

1.	Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand.
2.	Understand the relationship between a linear program and its dual, including strong duality and complementary slackness.
3.	Perform sensitivity analysis to determine the direction and magnitude of change of a model 's optimal solution as the data change.
4.	Solve specialized linear programming problems like the transportation and assignment problems.
5.	Solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
6.	Understand the applications of, basic methods for, and challenges in integer programming
7.	Model a dynamic system as a queuing model and compute important performance measures

Module	Detailed Content	No. of Hours
1	**Introduction to Operations Research**: Introduction, Historical Background, Scope of Operations Research, Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools, Structure of the Mathematical Model, Limitations of Operations Research	**2**
2	**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	**6**
3	**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.	**6**

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	Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem		
4	**Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory 's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.		5
5	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population		4
6	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation *Monte-Carlo Method:* Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation		4
7	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stagecoach/Shortest Path, cargo loading and Reliability		4
8	**Games 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.		4
9	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,		4
	Total		39

Reference Books :	
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.

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5	Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7016	**Cyber Security and Laws**	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Term Work	Pract & oral	Total	
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
IOC7016	**Cyber Security and Laws**	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7016	**Cyber Security and Laws**	**3**

Course Objectives:	
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

Course Outcomes:

The students 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

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Module		Detailed Content	No. of Hours
1		**Introduction to Cybercrime**	**4**
	1.1	Cybercrime definition, history and threats to security goals, Classifications of cybercrime, how criminal plan the attacks	
	1.2	The Need for an Indian Cyber Law, Introduction to Indian ITA 2000	
2		**Cyber frauds and Security issues**	**4**
	2.1	Social Engg, Cyber stalking, Online Drug Trafficking , Botnets, Attack vector, Credit Card Frauds in Mobile and Wireless Computing Era	
	2.2	Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, work from home cybersecurity Tips and Risks	
	2.3	Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	
		Self-Learning Topics: Types of Cyber Frauds and security issues	
3		**Tools and Methods Used in Cybercrime**	**10**
	3.1	Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography	
	3.2	DoS and DDoS Attacks, SQL Injection, Buffer Overflow,	
	3.3	Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	
4		**The Concept of Cyberspace**	**7**
	4.1	E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law	
	4.2	The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking	
5		**Indian IT Act**	**8**
	5.1	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	

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			Self-Learning Topics: Case Studies	
6			**Information Security Standard compliances**	**6**
		6.1	SOX, HIPAA, ISO	
			Self-Learning Topics: FISMA, NERC, PCI, GLBA	
			Total	**39**

Text Books:	
1	Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2	Cyber Security and Lawas, Madhumati Chatterjee, Sangita Chaudhary, Gaurav Sharma, Staredu solutions
3	Cyber Law & Cyber Crimes by Advocate Prashant Mali; Snow White Publications, Mumbai

References:	
1	The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
2	The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
3	Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
4	Kennetch J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
5	William Stallings, *Cryptography and Network Security,* Pearson Publication

Useful Links:	
1	The Information Technology ACT, 2008- TIFR: https://www.tifrh.res.in
2	A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer- professionals-33538

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7017	Disaster Management and Mitigation Measures (Abbreviated as DMMM)	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme				Term Work	Pract & oral	Total
		Theory						
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
IOC7017	Disaster Management and Mitigation Measures (Abbreviated as DMMM)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7017	Disaster Management and Mitigation Measures (Abbreviated as DMMM)	3

Course Objectives:	
1	To understand the 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 know warning systems, their implementation and based on this to initiate training to a laymen
6	To understand application of GIS in the field of disaster management

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7	To understand the emergency government response structures before, during and after disaster

Course Outcomes:

The students will be able to

1.	Understand natural as well as man made disaster and their extent and possible effects on the economy.
2.	Planning of national importance structures based upon the previous history.
3.	Understand government policies, acts and various organizational structures associated with an emergency.
4.	Know the simple do 's and don 'ts in such extreme events and act accordingly

Module	Detailed Content	No. of Hours
1	**Introduction:** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	3
2	**Natural Disaster and Manmade disasters:** Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion. Man made Disasters.	7
3	**Disaster Management, Policy and Administration:** Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co- ordination of in 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. disaster management, rescue operations- how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	7

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4	**Institutional Framework for Disaster Management in India:** Importance of public awareness, Preparation and execution of emergency management programmes. 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. Use of Internet and software for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.		7
5	**Financing Relief Measures:** Ways to raise finance for relief expenditure, Role of government agencies and NGOs in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.		9
6	**Preventive and Mitigation Measures:** Pre-disaster, during disaster and post- disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication. Non-Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do 's and don 'ts in case of disasters and effective implementation of relief aids.		6
		Total	39

Reference Books :	
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 Elseveir 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.

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| 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. |

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7018	Energy Audit and Management (Abbreviated as EAM)	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
IOC7018	Energy Audit and Management (Abbreviated as EAM)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7018	Energy Audit and Management (Abbreviated as EAM)	3

Course Objectives:	
1	To understand the importance of 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

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Course Outcomes:

The students will be able to

1.	To identify and describe the 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

Module	Detailed Content	No. of Hours
1	**Energy Scenario:** 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.	**4**
2	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Benchmarking, Energy performance, Matching energy use to requirement, maximizing system efficiencies, Optimizing the 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)	**8**
3	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting systems, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. **Energy conservation opportunities in:** water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	**10**

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4	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities	**10**
5	**Energy Performance Assessment:** 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.	**4**
6	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non- Conventional and Renewable Energy Sources	**3**
	Total	**39**

Reference Books :	
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 www.bee-india.nic.in

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC7019	Development Engineering (abbreviated as DE)	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Term Work	Pract & oral	Total	
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
ARC7019	Development Engineering (abbreviated as DE)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ARC7019	Development Engineering (abbreviated as DE)	3

Course Objectives:	
1	To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural
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

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Course Outcomes:	
The students 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

Module	Detailed Content	No. of Hours
1	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
2	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.	05
3	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; Database for local planning; Need for decentralized planning; Sustainable rural development.	06
4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology	05

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	and rural planning; Need for further amendments.	
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; 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 and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	05
	Total	**39**

Reference books :	
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
5.	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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Internal Assessment:

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5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

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Lab Code	Lab Name	Credit
ARL701	**Process Automation - Lab**	**1**

Prerequisite:

Lab Objectives:

1	To give the students fundamentals of automation and various automation systems used in industry such as PLC, DCS, and SCADA.
2	To impart the knowledge about the architecture, working of PLC, SCADA and DCS.
3	To give the students a comprehension of the aspects related to Safety Instrumented system (SIS)

Lab Outcomes:

1	Define automation, its need, importance and applications in industry.
2	Design PLC based application by proper selection and sizing criteria, developing GUI and ladder program.
3	Develop any application based on SCADA along with GUI using SCADA software
4	Develop DCS program using Function Block Diagram (FBD) method.
5	Describe database and alarm management system.
6	identify the need and components of safety instrumented system

Syllabus: Same as that of Subject ARC701

List of the Laboratory Experiments:

Sr .No.	Experiments
1.	Assignment/Exercise based on Automation Fundamentals
2.	Demonstration of PLC
3.	Processing of sensor signals by the PLC to drive various end effectors such as pneumatic/electric/hydraulic.
4.	PLC programs for process control applications (minimum 4 nos.)

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5.	GUI development for any application using SCADA software.
6.	DCS programming using Function block diagram method
7.	Assignment/Exercise based on DCS
8.	Assignment/Exercise based on SCADA
9.	Assignment based on Database and Alarm management
10.	Assignment based on Safety Instrumented System
11.	Any other experiments/assignments based on syllabus which will help students to understand the topic/concept. Industrial visit is advised to understand the Process Automation subject.

Any other experiment based on syllabus which will help students to understand the topic/concept.

Practical and Oral Examination:	
Practical and Oral examination will be based on entire syllabus of **ARC701**	

Term Work:	
1	Term work should consist of 08 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
ARL702	**Instrumentation Project Documentation and Execution -Lab**	**1**

Prerequisite:

Lab Objectives:

1	To provide knowledge of Instrumentation Project & Detailed Engineering techniques in the EPC Consultancy.
2	To make the students capable of executing Project Deliverables and Engineering activities of Project Documentation.

Lab Outcomes:

1	Interpret types of projects and execute them by knowing the relationship between customer, designer and constructor.
2	Apply standards in instrumentation projects and prepare basic engineering documents.
3	Design engineering documents such as loop diagram, hook-up, JB schedule.
4	Develop and test system integration.
5	Schedule and evaluate activities like procurement, commissioning, and installation.
6	Support and evaluate documentation software packages used in industry

List of the Laboratory Experiments:

Sr. No.	Experiments
1.	To study and draw Instrumentation symbols: ISA symbols CO1
2.	To study and prepare Process Flow Diagrams. CO2
3.	To develop P&ID diagram. CO2
4.	To prepare an instrument index sheet for tags used in P&ID. CO2
5.	To prepare a loop wiring diagram of any electronic/ pneumatic loop. CO3
6.	Study and prepare specification sheets for sample instruments. CO3

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7.	To prepare Installation details (Hook-up diagram) for DPT/ Thermowell CO4
8.	To study and preparation of Cable schedule
9.	To learn procedure to perform pre-commissioning activities CO5
10.	To study various software packages used for project documentation. CO6
11.	To prepare documents for Procurement activities: Inquiry, Quotation, Comparative statement, Purchase orders

Practical and Oral examination will be based on entire syllabus of **ARC702**	

Term Work:

1	Term work should consist of 08 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
ARL7011	Advanced Embedded Systems-Lab	1

Prerequisite:	

Lab Objectives:

1	Familiar with the basic concepts and terminology of the target area, the embedded systems design flow.
2	Able to program ARM cortex processor using assembly , embedded c hardware abstract language
3	Use RTOS for writing multithreaded tasks

Lab Outcomes:

1	Write embedded C program and program the ARM cortex processor
2	Use Hardware Abstract language to use the ARM processor peripherals
3	Interface various sensors and actuators to the ARM cortex processors
4	Write CMSIS RTOS code for the ARM processors

Syllabus: List of the Laboratory Experiments:

Sr. No.	Experiments
1.	Write program to blink LED
2.	Initialise the timer to blink the LED
3.	Intialise UART to communicate with PC
4.	Interface I2C,SPI devices
5.	Interface Display devices
6.	Intregace various actuators like relay,motors etc

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7.	Implement a project using RTOS

Note: Suggested List of Experiments is indicative. However, flexibility lies with individual course instructors to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Practical and Oral examination will be based on entire syllabus of **ARDOC7011 Advanced Embedded Systems**

Term Work:

1	Term work should consist of 7 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
ARL7012	**Advanced Biomedical Instrumentation-Lab**	**1**

Prerequisite: Basics of Biomedical Instrumentation systems

Lab Objectives:

1	To make students perform experiments based on the principle and working of various Biomedical Instruments used for Biopotential measurements
2	To develop skills in the design of various biomedical instruments used in diagnosis and Life-support.

Lab Outcomes:

1	Design ECG, EEG, and EMG amplifiers.
2	Design and/ or simulate prosthetic devices circuitry.
3	Design circuitry required for patient monitoring systems and telemetry
4	Distinguish between the various medical imaging techniques by comparing, principle and concept involved in each of the technique
5	Use fiber optics for healthcare applications.
6	Describe the significance of electrical safety in biomedical measurement.

Syllabus:

List of the Laboratory Experiments:

Sr. No.	Experiments
1	Design and implement ECG amplifier circuitry.
2	Design and implement EEG amplifier circuitry.
3	Design and implement EMG Quantification circuit.
4	Design asynchronous pacemaker circuit using op-amp or 555 timer.
5	Simulate Hemodialysis machine.

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6	Design the multiplexing circuitry for a bedside monitor.
7	Design and / or simulate a central nurse station.
8	Design and/or simulate ECG/EMG telemetry system
9	Assignment on image reconstruction of CT.
10	Distinguish imaging techniques such as MRI, PET and SPECT.
11	Simulate characteristics of optical fiber.
12	Study the characteristics of photo detectors.
13	Assignment on Radiation safety or Electrical safety or Fire safety in biomedical.

Any other experiment based on syllabus which will help students to understand the topic/concept.

Practical and Oral examination will be based on entire syllabus of **ARDOC 7012 Advanced Biomedical Instrumentation**	
Term Work:	
1	Term work should consist of 08 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
ARL7013	**Internet of Things-Lab**	**1**

Prerequisite:

Lab Objectives:

1	To impart knowledge about fundamentals of IoT
2	To describe data and knowledge management and use of devices in IoT technology.
3	To give knowledge of IoT architecture and Integration of embedded devices with IoT
4	To explain the concept of IIoT.
5	To impart knowledge about designing of industrial internet systems.
6	To describe overview of Android/ IOS app development tools and Internet of Everything

Lab Outcomes:

1	To demonstrate the knowledge of operation of IoT architecture and integrate hardware devices with IoT.
2	To explain possibilities offered by different technologies.
3	To explain and develop real world application comprising combination of such technologies in real life scenarios.
4	To discuss the concept of IIoT, IIoT Protocols- OPC-UA, the Message Queueing Telemetry Transport (MQTT) transfer protocol.
5	To design a simple IoT system comprising sensors, edge devices, wireless network connections and data analytics capabilities.
6	Use the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis.

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Syllabus: Same as that of Subject **ARDLO7013** Internet of Things.

List of the Laboratory Experiments:

Sr. No.	Experiments
1.	To design a simple IoT system comprising sensors.
2.	To design a simple IoT system connecting edge devices like actuator or motor.
3.	To design a simple IoT system for wireless network connections and data analytics capabilities.
4.	To build and test a complete, working IoT system involving prototyping, programming and data analysis.
5.	To design a case study on IoT system
6.	Assignment on understanding fundamentals of IoT Technology.
7.	Assignment on understanding integration of embedded devices with IoT Technology.
8.	Assignment on understanding fundamentals of IIoT Technology and challenges in it.
9.	Assignment on understanding fundamentals of designing industrial internet systems.

Practical and Oral examination will be based on entire syllabus of **ARDLO7013**

Term Work:

1	Term work should consist of 08 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
ARL7014	**Power Plant Automation Lab**	**1**

| **Prerequisite:** |||

| **Lab Objectives:** |||

1	To study the concept of power generation using various resources.
2	To study the role of Instrumentation in various power plants.
3	To study and compare various power plants for optimal performance.
4	To acquire students' knowledge about hazards and safety in handling power plant.

Lab Outcomes: The students will be able to:

1	Identify the energy sources and explain power generation.
2	Describe operation and control of various equipment in thermal power plant.
3	Select the sites for hydroelectric power plants and explain its operation.
4	Explain the power generation and control of Nuclear power.
5	Describe the non-conventional energy resources.
6	Compare different types of power plants.

Sr. No.	Experiments
1.	Assignment on Energy Scenario of India.

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2.	Assignment on Energy Sources.
3.	Assignment on Thermal Power plan.
4.	Assignment on comparison between water tube boiler and fire tube boiler.
5.	Assignment on Hydroelectric power plant.
6.	Assignment on Nuclear Power plant.
7.	Assignment on BWR and PWR Nuclear Power plants.
8.	Assignment on importance of Nonconventional Energy Resources.
9.	Assignment on Horizontal Axis and Vertical Axis Wind Turbines.
10.	Assignment on Stand Alone Solar PV system.
11.	Assignment on Grid Interactive Solar PV System.
12.	Assignment on Introduction to Hybrid Power generation concept.
13.	Assignment on Comparison of various power plants.

Industrial Visit to the Power plant is recommended.

Practical and Oral Examination:	
Oral examination will be based on entire syllabus of **ARDOC7014**	
Term Work:	
1	Term work should consist of 10 Assignments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
2	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
ARP701	**Major Project – I**	

Prerequisite:

Lab Objectives: The course is aimed

1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.

Lab Outcomes: On successful completion of course learner/student will be able to:

1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/ experimental/simulations.
5	Analyze the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices.
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.

Guidelines for Major Project

- Students should form groups with minimum 2(two) and not more than 4 (four)
- Students should do survey and identify needs, which shall be converted into problem statement for major project in consultation with faculty supervisor/head of department/internal committee of faculties.

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- Student shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during major project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model/software model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

Guidelines for Assessment of Major Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments. The progress of major project to be evaluated on continuous basis, minimum two reviews in the semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
  - · Marks awarded by guide/supervisor based on log book: 15
  - · Marks awarded by review committee: 15
  - · Quality of Project report: 20

Review/progress monitoring committee may consider following points for assessment.

- · In VII semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
  - o First shall be for finalization of problem

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- ○ o Second shall be on finalization of proposed solution of problem.

Assessment criteria of Major Project-I

Major Project-I shall be assessed based on following criteria;

1. Quality of survey/ need identification

2. Clarity of Problem definition based on need.

3. Innovativeness in solutions

4. Feasibility of proposed problem solutions and selection of best solution

5. Cost effectiveness

6. Societal impact

7. Innovativeness

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the Department.
- Major Project shall be assessed through a presentation and demonstration of working model/software model by the student   project group to a panel of Internal and External Examiners preferably from
- industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Major Project-I shall be assessed based on following points:

1. Quality of problem and Clarity

2. Innovativeness in solutions

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3. Cost effectiveness and Societal impact

4. Full functioning of working model/software model as per stated requirements

5. Effective use of skill sets

6. Effective use of standard engineering norms

7. Contribution of an individual as member or leader

8. Clarity in written and oral communication

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Program Structure for Final Year B.E Automation and Robotics
(With Effect from 2025-2026)
Scheme for Semester –VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract.Tut	Theory	Pract	Tut	Total
ARC801	Instrument and System Design	3	--	3	--	--	3
ARC802	Mobile Wheeled Robots	3	-	3	-	-	3
ARDOC801X	Department Elective– 4	3	-	3	--	--	3
IOC802X	Institute Elective	3	--	3	--	--	3
ARL801	Instrument and System Design – Lab	-	2		1	--	1
ARL802	Mobile Wheeled Robots-Lab	-	2		1	--	1
ARP801	Major Project-II	-	12#		6	--	6
	Total	12	16	12	8	--	20

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Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ARC801	Instrument and System Design	20	20	60	2	--	--	100
ARC802	Mobile Wheeled Robots	20	20	60	2	--	--	100
ARDOC801X	Department Elective– 4	20	20	60	2	--	--	100
IOC802X	Institute Elective	20	20	60	2	--	--	100
ARL801	Instrument and System Design – Lab	--	--	--	--	25	25	50
ARL802	Mobile Wheeled Robots-Lab	--	--	--	--	25	25	50
ARP801	Major Project-II	--	--	--	--	100	50	150
Total		80	80	240	10	150	100	650

# Indicates the workload of Learner (Not Faculty), for Major Project Students

group and a load of faculty per week.

Major Project - I and II:

Students can form groups with a minimum 2 (Two) and not more than 4(Four)

Faculty Load: In Semester VII– ½ hour per week per project group

In Semester VIII – 1-hour per week per project group

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Department Optional Course – 4 (Semester- VIII)

ARDOC 8021	Building Automation	
ARDOC 8022	Functional Safety	No Lab work
ARDOC 8023	Battery Management Systems	
ARDOC 8024	Unmanned Aerial Vehicle	

Institute Optional Course – 2 (Semester- VIII)

ARC8021	Project Management	ARC8026	Research Methodology
ARC8022	Finance Management	ARC8027	IPR and Patenting
ARC8023	Entrepreneurship Development and Management	ARC8028	Digital Business Management
ARC8024	Human Resource Management	ARC8029	Environmental Management
ARC8025	Professional Ethics and Corporate Social Responsibility		

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC801	Instrument and system design	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
ARC801	Instrument and system design	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARC801	Instrument and system design	3

Course Objectives:	
1	To impart knowledge of selection and design considerations of transducers along with their calibration techniques.
2	To make the students capable of sizing the control valve.
3	To create awareness about control valve problems.
4	To impart the students' knowledge about the types, sizing of control panels, and standards.
5	To make the students capable of designing electronic products, control room layout, and its environment.
6	To familiarize students with the concept of reliability engineering.

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Course Outcomes:	
The students will be able to	
1.	Select, design and calibrate transducers
2.	Select and size the control valves and actuators.
3.	Estimate valve noise and predict cavitation.
4.	Apply knowledge to design the control panels and control room.
5.	Design electronic products and enclosures.
6.	Define the terms used in Reliability engineering.

Module	Detailed Content	No. of Hours
1.	**Design of sensors and transducers:** An overview of static and dynamic performance characteristics of sensors and transducers. Selection guidelines, design considerations, calibration and installation for flow, temperature, pressure and level transducers.	7
2.	**Design of Control Valve:** Control valve terminology, Review of flow equations. Valve selection and sizing for liquid service, gas or vapor service, flashing liquids and mixed phase flow, Actuator sizing. Selection criteria and design consideration of pressure safety relief valves and rupture discs.	8
3.	**Cavitation , Flashing and Noise estimation:** Control valve noise, sources of noise, noise prediction, abatement of noise. Control valve cavitation and flashing and its effects, preventing cavitation, Prediction of cavitation.	6
4.	**Control Panel and Control room design** Need for control panel, Types, selection guidelines, Design considerations -size, construction and IP classification, NEMA standard. GA Diagrams, Power wiring and distribution, Earthing scheme. Panel ventilation, cooling and illumination. Operating consoles- ergonomics. Wiring accessories- ferrules, lugs, PVC ducts, spiral etc. Wire sizes and color coding. Packing, Pressurized panels- X, Y, and Z Purging for installation in	6

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	hazardous areas. Ex-proof panels. Intrinsic safe (IS) and non-intrinsic safe (non-IS) cabinet design. Control Room Design: Need for control room,conventional and modern control room Layout, Design considerations.	
5.	**Electronic product design:** System Engineering, Ergonomics, phases involved in electronic product design. Enclosure Design: Packing and enclosures design guidelines, Grounding and shielding, front panel and cabinet design of an electronic product.	6
6.	**Reliability engineering:** Reliability concepts, causes of failures, bathtub curve, Quality and reliability, MTTF, MTBF, and MTTR. Availability and Maintainability. Redundancy and redundant systems.	6
	Total	39

	Text Books:
1.	Curtis Johnson, "Process Control Instrumentation Technology", PHI/Pearson Education2002.
2.	Les Driskell, " Control Valve sizing" ISA Publication
3.	Kim R Fowler, Electronic Instrument Design, Oxford University-1996.
4.	B.C Nakra, K.K. Chaudhary, Instrumentation, Measurement and Analysis, Tata McGraw-Hill Education, 01-Oct-2003 - Electronic instruments - 632 page.
5.	Patranabis D, Sensors and Transducers, Prentice Hall India Learning Private Limited; 2 edition (2003) - 344 pages.
6.	A. K. Sawhney, Puneet Sawhney,A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co. Rai, 1996
7.	Rangan, Mani, Sharma. Instrumentation systems and Devices, 2 nd Ed.,Tata McGraw Hill.
8.	D.V.S. Murthi, ―Instrumentation and Measurement Principles‖, PHI, New Delhi, Second ed. 2003.

	References:
1.	Doeblin E.D., Measurement system, Tata McGraw Hill., 4th ed, 2003.
2.	Bela G. Liptak, Instrument Engineers' Handbook, Fourth Edition, Volume One: Process

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	Measurement and Analysis, June 27, 2003.
3.	Neubert Hermann K. P., Instrument Transducer, 2nd ed., Oxford University Press, New Delhi, 2003.
4.	Johnson Curtis D., Process Control Instrumentation Technology, 8th Ed., 2005
5.	S.P. Sukhatme, Heat Transfer, 3rd edition, University Press.
6.	B.E. Jones, Instrument Technology.
7.	Chortle Keith R., Fundamentals of Test, Measurement Instrument Instrumentation, ISA Publication.
8.	Alan S Morris, Measurement and Instrumentation Principles; 3rd Edition

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC802	Mobile Wheeled Robots	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC802	Mobile Wheeled Robots	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARC802	Mobile Wheeled Robots	3

Course Objectives:

Course Outcomes:

The students will be able to

1.	Learn algorithmic approaches, mathematical models and computational and motion control methods applicable to mobile robotic systems
2.	Learn basic sensor systems related to state measurements, navigation and localization.
3.	Learn different motion planning and navigation schemes related to mobile robots
4.	Recognize and analyze the basic mechanical and electrical systems concerning robots' locomotion and manipulation

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Module	Detailed Content	No. of Hours
1	Introduction to mobile robots and mobile manipulators. Principle of locomotion and types of locomotion. Types of mobile robots: ground robots (wheeled and legged robots), aerial robots, underwater robots and water surface robots.	6
2	Kinematics of wheeled mobile robot, degree of freedom and maneuverability, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots.	7
3	Sensors for mobile robot navigation: magnetic and optical position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual and motion sensing systems.	7
4	Robot navigation: Localization, Error propagation model, Probabilistic map based localization, Autonomous map building, Simultaneous localization and mapping (SLAM).	7
5	Motion and path planning: collision free path planning and sensor-based obstacle avoidance.	6
6	Motion control of mobile robots: Motion controlling methods, kinematic control, dynamic control and cascaded control.	6
	Total	**39**

References:	
1	R Siegwart, IR Nourbakhsh, D Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, USA, 2011.
2	SG Tzafestas, Introduction to Mobile Robot Control, Elsevier, USA, 2014.
3	A Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, USA, 2013.
4	S Thrun, W Burgard, D Fox, Probabilistic Robotics, MIT Press, USA, 2005.
5	G Dudek, M Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, USA, 2010.

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARDOC 8021	Building Automation	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARDOC 8021	Building Automation	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARDOC 8021	Building Automation	3

Course Prerequisite: Fundamental of measurement and control, industrial automation, smart buildings.	

Course Objectives:	
1	To train students with architecture and operation of Building Automation System.
2	To inculcate automation system design concepts for intelligent building.
3	Develop technique for preparation of various documents required for design requirements of safety building.

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Course Outcomes:		
The students will be able to		
1.	Explain the concept of intelligent building and Building Automation System.	
2.	Select the hardware and design of HVAC in the Building Automation System.	
3.	Discuss the concept of energy management system.	
4.	Design and implement the safety system for building.	
5.	Design security and video management system for building.	
6.	Design and integrate the different systems in the Building Automation System.	

Module	Detailed Content	No. of Hours
1	**Introduction to intelligent buildings:** Definitions of intelligent building, Intelligent architecture and structure, Facilities management vs. intelligent buildings, Technology systems and evolution of intelligent buildings. **Introduction to Building Automation System:** Features, Characteristics, Drawbacks of Building Automation system. **Various Systems of Building Automation** – Building Management System, Energy Management System, Security System, Safety System, Video Management System.	**06**
2	**HVAC system:** **Introduction, HVAC, Sensors & Transducers** – Temperature, Pressure, Level, Flow, RH. Meaning of Analog & Digital Signals, Valves and Actuators, Valve & Actuator Selection, Various Controllers, Concept of Controller IOs, Std Signals, Signal Compatibility between Controller & Field Devices. AHU – Concept, Components, Working Principle. AC Plant Room – Concept, Components, Refrigeration Cycle Working Principle, Chiller Sequencing, AC Plant Sequencing. **Feedback Control Loops, Heat** – Types, Heat Transfer Principles, Measurement of Heat Transfer. Psychrometry –Concept, ASHRAE Psychrometric Chart, Meaning of Various Terms – DBT, WBT, ST, RH, DPT, Sensible & Latent Cooling & Heating.	**08**

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3	**Energy Management System:** Concept, Energy Meters, Types, Meter Networking, Monitoring Energy Parameters, Analysis of Power Quality – Instantaneous Power, Active Power, Reactive Power, Power Factor, Voltage, Current. Effect of Power Quality on Energy Consumption, Energy Reports, Energy Conservation, Importance of Energy Saving.	**06**
4	**Safety Systems:** Introduction, Fire –Meaning, Fire Development Stages, Fire Sensors & Detectors, Detector Placement, Detectors Required For Various Applications. Fire Extinguishing Principles, Fire Extinguishers & Its Classification. Fire Alarm System – Controllers, Components, Features, Concept of Fire Loop & Fire Devices, 2-Wire & 4-Wire Loops, Working Principle, System Description, Pre-alarm, Alarm, Trouble, Fault, Differences, Cable Selection, Installation Guidelines Best Installation Practices	**07**
5	**Security Systems:** Introduction, Access Control – Concept, Generic Model, Components, Types, Features, Card Technologies, Protocols, Controllers, Concept of Anti-passback, Biometrics, Issues With Biometrics, Cabling, Video Door phone, Intrusion Detection System – Sensors, Working Principle, Access Control System Programming. Video Management: Introduction, CCTV Cameras, CCD Camera Basics, Traditional CCTV System, Video Recording, Drawbacks, Digital Video Recording, Features, Functionalities, Digital Vs Analog Recording.	**07**
6	**Integrated Systems:** Introduction, Integration of Building Management System, Energy Management System, Safety System, Security Systems & Video Management, Benefits of Integrated Systems, Challenges, Future Prospects of Integrated Systems.	**05**
	Total	**39**

Text Books:	
1	Shengwei Wang, Intelligent Buildings and Building Automation, 2009.
2	Reinhold A. Carlson Robert A. Di Giandomenico, ‗Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security Access Control, Lighting, Building‗,1st edition (R.S. Means Company Ltd), (1991).

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References:	
1	Roger W. Haines, "HVAC system Design Handbook", fifth edition.
2	National Joint Apprenticeship & Training Committee, Building Automation System Integration With Open Protocols: System Integration With Open Protocols
3	John I. Levenhagen and Donald H. Spethmann, HVAC Controls and Systems (Mechanical Engineering) , 1992.
4	James E.Brumbaugh, "HVAC fundamentals", vol: 1 to 3.

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARDOC 8022	Functional Safety	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARDOC 8022	Functional Safety	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARDOC 8022	Functional Safety	3

Course Objectives: To make the students aware of basic concepts of safety instrumented system, standards and risk analysis techniques

Course Outcomes:

The students will be able to

1.	Define the role of Safety instrumented systems in the industry.
2.	Explain process and safety control with SIS technologies
3.	Describe steps involved in Safety life cycle
4.	Calculate combined probability for different types of events.
5.	Analyse the potential hazards in the process.
6.	Determine the Safety integrity level.

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Module	Detailed Content	No. of Hours
1	**Introduction:** Safety Instrumented System (SIS) - need, features, components, difference between basic process control system and SIS, Risk: how to measure risk, risk tolerance, Safety integrity level, safety instrumented functions. Standards and Regulation – HSE-PES, AIChE-CCPS, IEC-61508, IEC 61511 (2-16), ANSI/ISA-84.00.01-2004 (IEC 61511 Mod) & ANSI/ISA –84.01-1996.9, NFPA 85.10, API RP 556, API RP 14C, OSHA (29CFR 1910.119 – Process Safety Management of Highly Hazardous Chemicals), IEC61513, IEC 60601, ISO 26262, IEC 62443	6
2	**Process Control –** Active / Dynamic, Safety Control – Passive / Dormant, Demand Mode vs. Continuous Mode, Common Cause and Systematic or Functional Failures**.** **Protection Layers:** prevention and mitigation layers, SIS Technologies: Pneumatic Systems, Relay Systems, Solid State Systems, Microprocessors / PLC (Software based) Systems, voting logic in SIS	8
3	**Safety life cycle:** Standards and safety life cycle, analysis phase, tolerable risk, risk identification and hazard analysis, SIF identification, realization phase, operations phase.	5
4	**Rules of Probability:** Assigning probability to an event, types of events and event combination, combining event probabilities, failure rate and probability, simplifications and approximations.	8
5	**Process Hazard Analysis:** **Consequence analysis:** Characterization of potential events, dispersion, impacts, effect zone, occupancy considerations, consequence analysis too**ls.** **Likelihood analysis:** statistical analysis, fault propagation modeling, event tree analysis and fault tree analysis, reliability block diagram, markov analysis, Quantitative layer of protection analysis: multiple initiating events, estimating initiating event frequencies and IPL failure probabilities.	6

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			6
6	**Determining the Safety Integrity Level (SIL):** Evaluating Risk, Safety Integrity Levels, SIL Determination Method: As Low as Reasonably Practical (ALARP), Risk matrix, Risk Graph, Layers of Protection Analysis (LOPA)		
		Total	**39**

Text Books:	
1	Paul Gruhn and H Jarry L. Cheddie," Safety Instrumented systems: Design, Analysis and Justification", ISA, 2nd edition, 2006
2	Ed Marszal, Eric W Scharpf, "Safety Integrity Level Selection", ISA.

References:	
1	Bela G. Liptak, Instrument Engineers' Handbook, Fourth Edition, Volume One: Process Measurement and Analysis, June 27, 2003
2	Dr. Eric W Scharpf, Heidi J Hartmann, Harlod W Thomas, "Practical SIL target selection: Risk analysis per the IEC 61511 safety Lifecycle", exida, 2012.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARDOC 8023	Battery Management Systems	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Term Work	Pract & oral	Total	
		Internal Assessment		End Se Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARDOC 8023	Battery Management Systems	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARDOC 8023	Battery Management Systems	3

Course Objectives:	
1	Teach fundamental battery chemistry
2	Teach the various charging control schemes
3	Model the battery for various applications

Course Outcomes:	
The students will be able to	
1.	Interpret the role of battery management system
2.	Identify the requirements of Battery Management System

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3.	Interpret the concept associated with battery charging / discharging process
4.	Calculate the various parameters of battery and battery pack
5	Design the model of battery pack

Module	Detailed Content	No. of Hours
1	**Introduction**: Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging	8
2	**Battery Management System Requirement:** Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-ofcharge estimation, Cell total energy and cell total power,	9
3	Battery State of Charge and State of Health Estimation, Cell Balancing: Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing	9
4	**Modelling and Simulation:** Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, Simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs,	8
5	**Design of battery BMS:** Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system	5
	Total	**39**

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	References:
1	Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2	Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
3	Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
4	Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs"Artech House, 2010
5.	Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARDOC 8024	Unmanned Aerial Vehicle	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Se Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARDOC 8024	Unmanned Aerial Vehicle	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARDOC 8024	Unmanned Aerial Vehicle	3

Course Objectives:	
1	Learn concepts of UAV and UAV Technology
2	Impart Knowledge of Aerodynamic configuration for a UAV
3	Impart knowledge navigation and control modes for a UAV
4	Learn the various certification required for UAV

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Course Outcomes:	
The students will be able to	
1.	To understand the evolution and the basic classification of unmanned aerial vehicles.
2.	To develop aerodynamic configuration for a UAV.
3.	To select navigation and control modes for a UAV.
4.	. To understand the method of testing and certification involved in development of UAV

Module	Detailed Content	No. of Hours
1	Introduction to Unmanned Aircraft Systems (UAS), Introduction to Design and Selection of the System, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects	6
2	Aerodynamics and Airframe configurations- Lift-induced Drag, Parasitic Drag, Rotary-wing Aerodynamics, Response to Air Turbulence, Airframe Configurations	8
3	Aspects of Airframe Design- Scale Effects, Packaging Density, Aerodynamics, Structures and Mechanisms, Selection of power-plants, Modular Construction, Ancillary Equipment Design for Stealth- Acoustic Signature, Visual Signature, Thermal Signature, Radio/Radar Signature, Examples in Practice	8
4	Communication Media, Radio Communication, Mid-air Collision (MAC) Avoidance, Communications Data Rate and Bandwidth Usage, Antenna Types, NAVSTAR Global Positioning System (GPS), TACAN, LORAN, INS, Radio Tracking, Way-point Navigation	8
5	Control Station Composition, Open System Architecture, Mini-UAV 'Laptop' Ground Control Station, Close-range UAV Systems GCS, Medium- and Long-range UAV System GCS, Sea Control Stations (SCS), Air Control Stations (ACS).	5
6	Introduction to System Development and Certification, System Development, Certification, Establishing Reliability, System Ground Testing, System In-flight Testing	4
	Total	39

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Text Books:	
1	Unmanned Aircraft Design A review of fundamentals by Mohammad H. Sadraey
2	Aircraft performance and design by John D. Anderson
3	Introduction to Flight by John D. Anderson

References:	
1	Gundlach J.: "Designing Unmanned Aircraft Systems: A comprehensive Approach", AIAA Publishing Company, Inc., 2012.
2	Aircraft Design : A Conceptual Approach by Daniel P. Raymer
3	Unmanned Aircraft Systems : UAVs Design Development and Deployment by Reg Austin
4	Small Unmanned Fixed-wing Aircraft Design: A Practical Approach by Andrew J. Keane and James P. Scanlan
Weblinks	
1	https://archive.nptel.ac.in/courses/101/104/101104083/
2	https://archive.nptel.ac.in/courses/101/104/101104073/

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC8021	Project Management (abbreviated as PM)	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC8021	Project Management (abbreviated as PM)	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARC8021	Project Management (abbreviated as PM)	3

Course 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

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Course Outcomes:	
The students 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 Content	No. of Hours
1	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	**5**
2	**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 project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
3	**Project Planning and Scheduling:** 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).	8
4	**Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
5	**Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team	8

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	management, communication and project meetings. **Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **Project Contracting** Project procurement management, contracting and outsourcing,	
6	**Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **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.	**6**
	Total	**39**

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

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

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Institute level Elective -

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC8022	Finance Management (abbreviated as FM)	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC8022	Finance Management (abbreviated as FM)	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARC8022	Finance Management (abbreviated as FM)	3

Course 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

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Course Outcomes:

The students will be able to

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

Module	Detailed Content	No. of Hours
1	**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	**09**
2	**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.	**10**
3	**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, 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.	**10**
4	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for	**10**

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	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.		
5		**Total**	**39**

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

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Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC8023	Entrepreneurship Development and Management (abbreviated as EDM)	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Se Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC8023	Entrepreneurship Development and Management (abbreviated as EDM)	20	20	60	2	--	--	100

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Course Code	Course Title	Credit
ARC8023	**Entrepreneurship Development and Management (abbreviated as EDM)**	**3**

Course Objectives:	
1	To acquaint with entrepreneurship and management of business
2	Understand Indian environment for entrepreneurship
3	Idea of EDP, MSME

Course Outcomes:

The students 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 Content	No. of Hours
1	**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	**4**
2	**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	**9**

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3	Women 's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	**5**
4	**Indian Environment for Entrepreneurship:** 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.	**8**
5	**Effective Management of Business:** 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	**8**
6	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	**5**
	Total	
		39

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

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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

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC8024	Human Resource Management (abbreviated as HRM)	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
ARC8024	Human Resource Management (abbreviated as HRM)	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARC8024	Human Resource Management (abbreviated as HRM)	3

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Course 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.
3	To familiarize the students about the latest developments, trends & different aspects of HRM.
4	To acquaint the student with the importance of behavioral skills, Inter- personal, inter- group in an Organizational setting.
5	To prepare the students as future organizational change facilitators, stable leaders and managers, Using the knowledge and techniques of human resource management.

Course Outcomes:	
The students will be able to	
1.	Gain knowledge and understand the concepts about the different aspects of the human resource management.
2.	Understand and tackle the changes and challenges in today's diverse, dynamic organizational setting and culture.
3.	Utilize the behavioral skill sets learnt, in working with different people, teams & groups within the national and global environment.
4.	Apply the acquired techniques, knowledge and integrate it within the engineering/ non engineering working environment emerging as future engineers and managers.

Module	Detailed Content	No. of Hours
1	**Introduction to HR:** Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	**05**

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2	**Organizational Behavior (OB) :** Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues, Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness, Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	**07**
3	**Organizational Structure & Design:** Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	**06**
4	**Human resource Planning:** Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods	**05**
5	**Emerging Trends in HR :** Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment, Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	**06**
6	**HR & MIS:** 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**	**10**

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	Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; 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, Shops and Establishments Act	
	Total	**39**

References:	
1	Stephen Robbins, Organizational Behavior, 16
2	V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3	Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4	C. B. Mamoria and S V Gankar,
5	P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

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Department of Automation and Robotics

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC8025	Professional Ethics and Corporate Social Responsibility (abbreviated as PECSR)	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory			Term Work	Pract & oral	Total	
		Internal Assessment		End Se Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC8025	Professional Ethics and Corporate Social Responsibility (abbreviated as PECSR)	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARC8025	Professional Ethics and Corporate Social Responsibility (abbreviated as PECSR)	3

Course Objectives:	
1	To understand professional ethics in business
2	To recognized corporate social responsibility

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Course Outcomes:	
The students will be able to	
1.	Understand rights and duties of business
2.	Distinguish different aspects of corporate social responsibility
3.	Demonstrate professional ethics
4.	Understand legal aspects of corporate social responsibility

Module	Detailed Content	No. of Hours
1	**Professional Ethics and Business:** 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**
2	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving depleting Resources	**08**
3	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	**06**
4	**Introduction to Corporate Social Responsibility:** Potential Business Benefits— Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	**05**

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5	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	**08**
6	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility— Companies Act, 2013.	**08**
	Total	39

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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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC8026	**Research Methodology (abbreviated as RM)**	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Se Exam	Exam Dur (Hrs)			
		Mid Test (MT)	**CA ***					
ARC8026	Research Methodology (abbreviated as RM)	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARC8026	Research Methodology (abbreviated as RM)	3

Course 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

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Course Outcomes:	
The students 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 Content	No. of Hours
1	**Introduction and Basic Research Concepts:** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology, Need of Research in Business and Social Sciences, Objectives of Research, **Issues** and Problems in Research, Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	**10**
2	**Types of Research:** Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical Research, Qualitative and Quantitative Approaches	**07**
3	**Research Design and Sample Design:** Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
4	**Research Methodology:** Meaning of Research Methodology, Stages in Scientific Research Process a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis **i.** Hypothesis testing and Interpretation of Data h. Preparation of Research Report	**07**

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5	**Formulating Research Problem:** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
6	**Outcome of Research:** Preparation of the report on conclusion reached, Validity Testing & Ethical Issues, Suggestions and Recommendation	**04**
	Total	39

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, (2nde), Singapore, Pearson Education

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC8027	IPR and Patenting (abbreviated as IPRP)	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC8027	IPR and Patenting (abbreviated as IPRP)	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARC8027	IPR and Patenting (abbreviated as IPRP)	3

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Course 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

Course Outcomes:	
The students 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 Content	No. of Hours
1	**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**
2	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, international agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	**07**
3	**Emerging Issues in IPR:** Challenges for IP in digital economy, e- commerce, human genome, biodiversity and traditional knowledge etc.	**06**

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4	**Basics of Patents:** 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**
5	**Patent Rules:** 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**
6	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc., Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	**06**
	Total	39

References:	
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, 7th Edition, Sweet & Maxwell
6	Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd 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,

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	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,
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

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Internal Assessment:

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Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

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5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC8028	**Digital Business Management (abbreviated as DBM)**	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		**End Se Exam**	Exam Dur (Hrs)			
		Mid Test (MT)	**CA ***					
ARC8028	**Digital Business Management (abbreviated as DBM)**	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARC8028	**Digital Business Management (abbreviated as DBM)**	**3**

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

Course Outcomes:	
The students 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	No. of 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) Opportunities and Challenges in Digital Business,	**09**
2	**Overview of E-Commerce: E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement 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 Other E-C models and applications, innovative EC System-From E- government and learning to C2C, mobile commerce and pervasive computing 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 pro ject, Legal, Ethics and Societal impacts of EC	**06**
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system, **Application Development:** Building Digital business Applications and Infrastructure	**06**
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business, Security Threats to e- business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography,	**06**

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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 plan preparation	**08**
	Total	**39**

	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, 6th 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, 2nd Edition, Pearson
6	Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7	Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8	E-Governance-Challenges and Opportunities in : Proceedings in 2nd 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-en OECD Publishing

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC8029	**Environmental Management (abbreviated as EVM)**	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme				Term Work	Pract & oral	Total
		Theory						
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
ARC8029	**Environmental Management (abbreviated as EVM)**	20	20	60	2	--	--	100

Course Code	Course Title	Credit
ARC8029	**Environmental Management (abbreviated as EVM)**	3

Course Objectives:		
1	Understand and identify environmental issues relevant to India and global concerns	
2	Learn concepts of ecology	
3	Familiarize environment related legislation	

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Course Outcomes:	
The students 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 Content	No. of Hours
1	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, and the Energy scenario.	**10**
2	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.	**06**
3	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	**05**
4	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	**10**
5	Total Quality Environmental Management, ISO-14000, EMS certification.	**05**
6	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**
	Total	**39**

References:	
1	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, T V Ramachandra and Vijay Kulkarni, TERI Press
4	Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005

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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, 3rd Ed. Access Publishing.2015

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Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

	End Semester Theory Examination:	
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

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Lab Code	Lab Name	Credit
ARL801	**Instrument and System Design - Lab**	**1**

Prerequisite:	

Lab Objectives:

1	To impart knowledge of selection and design considerations of transducers along with its calibration techniques.
2	To make the students capable of sizing the control valve.
3	To give the students' knowledge about the types, sizing of control panels and standards
4	To make the students capable to apply knowledge to design electronic product, control room layout and its environment
5	To give the students a comprehension of the aspects of reliability engineering.

Lab Outcomes:

1	Calculate performance characteristics of a given transducer and calibrate transducers.
2	Select and size the control valves and actuators.
3	Estimate valve noise and predict cavitation
4	Apply knowledge to design the control panels and control room.
5	Apply knowledge to design electronic product
6	Calculate Reliability engineering terms

Syllabus: Same as that of Subject ARC801.
List of the Laboratory Experiments:

Sr No.	Experiments
1.	Study the performance characteristics of Flow instruments.
2.	Study the performance characteristics of Level instruments
3.	Study the performance characteristics of Pressure instruments

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4.	Study the performance characteristics of Temperature instruments
5.	To verify flow capacity of a given valve. (use Cv characteristic set up)
6.	Study of control panel and its GA / wiring drawings
7.	To develop laboratory control room layout.
8.	Study and familiarization of Installations of Field instruments.
9.	Study and familiarization of valve actuators and positioners..
10.	To study control valve performance.
11.	Perform Hydro and seat Leakage test for control valves.
12.	Study operation of Field instruments and its specifications
13.	Study and testing of controller configuration
14.	Any other Experiment as per syllabus requirements

Any other experiment based on syllabus which will help students to understand topic/concept.

Practical and Oral Examination:	
Practical and Oral examination will be based on entire syllabus of **ARC801**	
Term Work:	
1.	Term work should consist of 08 experiments.
2.	Journal must include at least 2 assignments.
3.	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4.	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Lab Code	Lab Name	Credit
ARL802	Mobile Wheeled Robots- Lab	**1**

Prerequisite:

Lab Objectives:

1	To study Robot programming fundamentals and ROS platform
2	To understand the installation and applications of ROS
3	To understand the Robot navigation through Simulations.

Lab Outcomes:

1	Demonstrate knowledge of operating system dedicated to Robot
2	Analyze various case studies of ROS application
3	Apply spatial transformation to obtain forward and inverse kinematics through programming
4	Solve robot dynamics problems, generate joint trajectory for path planning and Programming
5	Apply working principle of various ROS debugging process
6	Identify applications of robots in industry

Syllabus: Same as that of Subject ARC802. **List of the Laboratory Experiments:**	
Sr No.	**Experiments**

1.	**ROS and Embedded System programming**
	    1. Introduction to ROS serial
	    2. Working with ROS and Arduino
	    3. Working with Jetson Nano and ROS
	    4. Setting ROS vision in Jetson Nano
	    5. Working with ROS and Raspberry Pi
	    6. Interfacing RPI camera to ROS
	    7. Interfacing GPIO pins of RPI using ROS
	    8. Interfacing sensors to RPI and ROS
	    9. Controlling motors from RPI and ROS

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2.	**Building cheapest autonomous mobile robot using ROS** 1. Creating a robot model of a delivery robot 2. Interfacing our mobile robot to ROS navigation stack 3. Implement Mapping and Localization using SLAM and AMCL 4. How to tune Navigation parameters 5. Commanding robot using GUI
3.	**ROS-SLAM** 1. List of SLAM wrappers in ROS 2. Gmapping, Cartographer 3. Deep dive into Visual SLAM 4. Configuring different SLAM package for your robot
4.	**ROS Path planners** 1. Deep dive into ROS based path planners 2. Working with existing planners in ROS 3. Configuring a planner for your robot 4. Writing your own planner for your robot

Any other experiments/assignments based on syllabus which will help students to understand topic/concept.

Practical and Oral Examination:	
Practical and Oral examination will be based on entire syllabus of **ARC802**	
Term Work:	
1.	Term work should consist of 08 experiments.
2.	Journal must include at least 2 assignments.
3.	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4.	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISP801	**Major Project – II**	--	12#	--	6		6

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ISP801	Major Project-II	--	--	--	--	100	50	150

Course Code	Course Title	Credit
ISP801	**Major Project-II**	6

Course Objectives:	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.

Course Outcomes:
The students will be able to
1. Identify problems based on societal /research needs.

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2.	Apply Knowledge and skill to solve societal problems in a group.
3.	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/ experimental/simulations.
5	Analyze the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.

Guidelines for Major Project:

· Students should form groups with minimum 2(two) and not more than 4 (four)

· Students should do survey and identify needs, which shall be converted into problem statement for major project in consultation with faculty supervisor/head of department/internal committee of faculties.

· Student shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project.

· A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

· Faculty supervisor may give inputs to students during major project activity; however, focus shall be on self-learning.

· Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

· Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

· The solution to be validated with proper justification and report to be compiled in standard

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format of Department.

·   With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

Guidelines for Assessment of Major Project: Term Work

·   The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in the semester.

·   In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below

·   **Quality of Project report**

:30

·   **Marks awarded by review committee**

: 30

·   **Marks awarded by guide/supervisor based on log book**   **: 40**

Review/progress monitoring committee may consider following Points for assessment:

·   In VIII semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

· First review is based on readiness of building working prototype to be conducted.

· Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

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Assessment criteria of Major Project-II

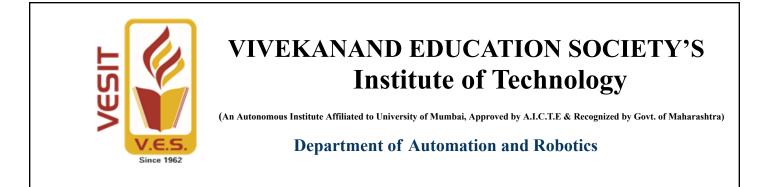**Major Project-II shall be assessed based on following criteria;**

1. **Cost effectiveness and Societal impact**

2. **Full functioning of working model as per stated requirements**

3. **Effective use of skill sets**

4. **Effective use of standard engineering norms**

5. **Contribution of an individual's as member or leader**

6. **Clarity in written and oral communication**

Guidelines for Assessment of Major Project Practical/Oral Examination:

- **Report should be prepared as per the guidelines issued by the University of Mumbai.**
- **Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.**
- **Students shall be motivated to publish a paper based on the work in Conferences/students competitions.**

Major Project shall be assessed based on following points:

1 **Quality of problem and Clarity**

2 **Innovativeness in solutions**

3 **Cost effectiveness and Societal impact**

4 **Full functioning of working model as per stated requirements**

5 **Effective use of skill sets**

6 **Effective use of standard engineering norms**

7 **Contribution of an individuals as member or leader**

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8 Clarity in written and oral communication