MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB
(Formerly West Bengal University of Technology)

Syllabus for B. Sc. In Robotics & Robot process automation (RPA) (In-house)
(Effective for Students Admitted in Academic Session 2022-2023)
In CBCS Format

Programme Outcomes (POs):

The graduates of Robotics & Robot Process Automation will be able to:

PO – 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO – 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO – 3: Design/development of solutions: Design solutions for complex engineering problems and design system component or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO – 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO – 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO – 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO – 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO – 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO – 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO – 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO – 11: Project management and finance: Demonstrate knowledge and understanding of the engineering an management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO – 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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CURRICULUM STRUCTURE

1st Semester

Subject Type			Course Code	Course Name	Credit Points	Credit Distribution			Mode of Delivery		
						Th	Pr	Tu	Offline	Online	Blended
Core course	CC1	CC 1.1	RBEE101	Basic Electrical Engineering	4	4	0	0	✓	✓	✓
		CC1.2	RBEE191	Basic Electrical Engineering Lab	2	0	2	0	✓	✓	✓
	CC2	CC2.1	RBMS101	Engineering Mechanics	4	4	0	0	✓	✓	✓
		CC2.2	RBMS191	Engineering Graphics	2	0	2	0	✓	✓	✓
GE		GE1.1	RBM101	Engineering Mathematics I	4	4	0	0	✓	✓	✓
		GE1.2	RBMT101	Engineering Mathematics I Tutorial	2	0	0	2	✓	✓	✓
AECC		AECC 1	RBHS101	Communicative English	2	2	0	0	✓	✓	✓
	Semester Credits				**20**						

2nd Semester

Subject Type			Course Code	Course Name	Credit Points	Credit Distribution			Mode of Delivery		
						Th	pr	Tu	Offline	Online	Blended
CC	CC3	CC 3.1	RBEC201	Analog & Digital Electronics	4	4	0	0	✓	✓	✓
		CC 3.2	RBEC291	Analog & Digital Electronics lab	2	0	2	0	✓	✓	✓
	CC4	CC 4.1	RBMS201	Strength of Materials for Mechanical Engineers	4	4	0	0	✓	✓	✓
		CC 4.2	RBMS291	Strength of Materials for Mechanical Engineers lab	2	0	2	0	✓	✓	✓
GE		GE 2.1	RBM201	Engineering Mathematics II	4	4	0	0	✓	✓	✓

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		GE 2.2	RBMT201	Engineering Mathematics II Tutorial	2	0	0	2	✓	✓	✓
AECC		AECC 2	RBPR201	Environmental Science	2	2	0	0	✓	✓	✓
	Semester Credits				**20**						

3rd Semester

Subject Type			**Course Code**	**Course Name**	**Credit Points**	**Credit Distribution**			**Mode of Delivery**		
						Th	Pr	Tu	Offline	Online	Blended
CC	CC5	CC5.1	RBEC301	Electrical Machines	4	4	0	0	✓	✓	✓
		CC5.2	RBEC391	Electrical Machines Lab	2	0	2	0	✓	✓	✓
	CC6	CC6.1	RBEC302	Microprocessors, Embedded Controllers and Real time Operating Systems	4	4	0	0	✓	✓	✓
		CC6.2	RBEC392	Microprocessors, Embedded Controllers and Real time Operating Systems lab	2	0	2	0	✓	✓	✓
	CC7	CC7.1	RBMS301	Kinematics & Dynamics of Machines	4	4	0	0	✓	✓	✓
		CC7.2	RBMS391	Kinematics & Dynamics of Machines lab	2	0	2	0	✓	✓	✓
GE		GE 3.1	RBPH301	Digital signal processing (DSP)	4	4	0	0	✓	✓	✓
		GE 3.2	RBPHT301	Digital signal processing (DSP) Lab	2	0	0	2	✓	✓	✓
SEC		SEC1.1	RBCS301	Introduction to python *	2	2	0	0	✓	✓	✓
	Semester Credits				**26**						

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***Course to be completed from MOOCs Platform.**

4th Semester

`Subject Type			**Course Code**	**Course Name**	**Credit Points**	**Credit Distribution**			**Mode of Delivery**		
						Th	Pr	Tu	Offline	Online	Blended
CC	CC 8	CC8.1	RBEE401	Power Electronics and Drives	4	4	0	0	✓	✓	✓
		CC8.2	RBEE491	Power Electronics and Drives Lab	2	0	2	0	✓	✓	✓
	CC9	CC9.1	RBEC401	Sensors and Instrumentation	4	4	0	0	✓	✓	✓
		CC9.2	RBEC491	Sensors and Instrumentation Lab	2	0	2	0	✓	✓	✓
	CC 10	CC10.1	RBPR401	Principles of Robotics I	4	4	0	0	✓	✓	✓
		CC10.2	RBPR491	Principle Robotics Lab I	2	0	2	0	✓	✓	✓
GE		GE 4.1	RBHU401	Values & Ethics*	4	4	0	0	✓	✓	✓
		GE 4.2	RBHUT401	Values & Ethics Tutorial *	2	0	0	2	✓	✓	✓
SEC		SEC1.1	RBCS401	Machine Learning,*	2	2	0	0	✓	✓	✓
	Semester Credits				**26**						

***Course to be completed from MOOCs Platform.**

5th Semester

Subject Type			**Course Code**	**Course Name**	**Credit Points**	**Credit Distribution**			**Mode of Delivery**		
						Th	Pr	Tu	Offline	Online	Blended
CC	CC11	CC11.1	RBEE501	Control System	4	4	0	0	✓	✓	✓

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		CC 11.2	RBEE591	Control System Lab	2	0	2	0	✓	✓	✓
	CC12	CC12.1	RBPR501	Introduction to Robotics II	4	4	0	0	✓	✓	✓
		CC12.2	RBPR592	Robotics II Lab	2	0	2	0	✓	✓	✓
DSE		DSE 1.1	RBPR502	Industrial Design And Applied Ergonomics	4	4	0	0	✓	✓	✓
		DSE1.2	RBPR592	Industrial Design And Applied Ergonomics lab	2	0	2	0	✓	✓	✓
DSE		DSE 2.1	RBMS501	Mechanical design	4	4	0	0	✓	✓	✓
		DSE2.2	RBMS591	Mechanical Design lab	2	0	2	0	✓	✓	✓
		Semester Credits			**24**						

***Course to be completed from MOOCs Platform.**

6th Semester

Subject Type			**Course Code**	**Course Name**	**Credit Points**	**Credit Distribution**			**Mode of Delivery**		
						Th	Pr	Tu	Offline	Online	Blended
CC	CC13	CC13.1	RBPR601	3D Printing	4	4	0	0	✓	✓	✓
		CC 13.2	RBPR691	3D Printing Lab	2	0	2	0	✓	✓	✓
	CC14	CC14.1	RBCS601	Machine Vision	4	4	0	0	✓	✓	✓
		CC14.2	RBCS691	Machine Vision Lab	2	0	2	0	✓	✓	✓
DSE		DSE 3.1	RBCS602	Internet of things*	4	4	0	0	✓	✓	✓
		DSE3.2	RBCS692	Internet of things Lab *	2	0	2	0	✓	✓	✓
DSE		DSE 4.1	RBPR692	Project	6	4	0	0	✓	✓	✓
		Semester Credits			**24**						

	GRAND TOTAL Credits	**140**						

***Course to be completed from MOOCs Platform.**

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Semester-I

DETAILED SYLLABUS

Paper Name: Basic Electrical Engineering
Code: RB-EE 101
Contact: 3L+1T
Credits: 3
Allotted Hrs: 36

Aim:
Basic electrical engineering is an introductory course in electrical engineering. Students are introduced to simple applied electrical circuits, theories and practice to impart skill set to have visualization of electrical engineering applications. It is a course suitable for students pursuing electrical engineering as well as other related engineering disciplines.

Course Objective:
The course objectives are:
1. Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.
2. Provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.
3. Explain the working principle, construction, applications of DC machines, AC machines & measuring instruments.
4. Identification the importance of transformers in transmission and distribution of electric power.
5. Explain basic knowledge of LT Switch Gears, Circuit Breakers and Earthing for domestic application.
6. Give basic idea of Power converters and their applications.

Detailed contents

Module 1: DC Circuits (8 hours)

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

Module 2: AC Circuits (8 hours)

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

Module 3: Transformers (6 hours)

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Module 4: Electrical Machines (8 hours)

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

Module 5: Power Converters (6 hours)

DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

Module 6: Electrical Installations (6 hours)

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Suggested Text / Reference Books

(i) D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.

(ii) D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.

(iii)L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.

(iv)E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.

(v) V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.

Course Outcomes:

On completion of the course, student will able to-

1. Classify of Electrical Elements and Energy Sources.

2. Solve simple DC Circuits and Network Theorems.

3. Analyze RLC Combination in Time Domain.

4. Specify a Sinusoidal Waveform with drawing phasor diagram.

5. Classify Power and determine Power Factor.

6. Solve AC RLC Series-Parallel Combination problems.

7. Analyse Three Phase balanced circuits.

8. Specify in detail ideal and practical transformers.

9. Calculate parameters of transformers.

10. Performance and application of Autotransformer and three phase connections.

11. Concept of generation of magnetic field.

12. Calculate parameters of Three Phase Induction Motor and analyze performance.

13. Calculate parameters of Single Phase Induction Motor and analyze performance.

14. Calculate parameters of Separately Exited DC Motor and analyze performance.

15. Calculate parameters of Synchronous Generator and analyze performance.

16. Classify Power Converters and analyze performance of power converter.

17. Identification of LT Switchgear, Circuit Breaker and Earthing and their application.

18. Identify Wires and Cables.

19. Calculate parameters of Battery and its performance analysis.

(ii)Basic Electrical Engineering Laboratory [L : 0; T:0 ; P : 2 (1 credit)]

List of experiments/demonstrations:

- Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
- Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
- Transformers: Observation of the no-load current waveform on an oscilloscope (non sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a

discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.

- Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.
- Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
- Torque Speed Characteristic of separately excited dc motor.
- Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at supersynchronous speed.
- Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
- Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

Laboratory Outcomes:

On completion of the course, student will able to-

1. Identify and use Electrical Elements and Measuring Instruments.

2. Measure Time Response of RLC Circuits and Resonance.

3. Analyse performance of Single Phase Transformer.

4. Analyse performance of Three Phase Transformer.

5. Identify parts of DC Machines, Induction Machine, Synchronous Machine, Single Phase Induction Machine.

6. Analyse performance of Induction Motor.

7. Analyse performance of DC Motor.

8. Identify LT Switchgears.

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Paper Name: Engineering Mechanics
Code: RBMS 101
Contact hours/week: 3L+1T
Credits: 3

Aim: Engineering Mechanics is an introductory course in Robotics & 3D Printing. The topics introduced will serve as basic tools for specialized studies in many fields of Robotics and 3D Printing.

COURSE OBJECTIVE:

- To introduce the basic principles of engineering mechanics with emphasis on their analysis and application to practical engineering problems
- To determine the representation of forces and moments
- To describe static equilibrium of particles and rigid bodies
- To comprehend the effect of Friction on general plane motion
- To analyse the properties of surfaces & solids in relation to moment of inertia
- To illustrate the laws of motion, kinematics of motion and their interrelationship

UNIT I STATICS OF PARTICLES 9+6
Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

UNIT II EQUILIBRIUM OF RIGID BODIES
9+6
Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

UNIT III PROPERTIES OF SURFACES AND SOLIDS 9+6
Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard

formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 9+6

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND RIGID BODY DYNAMICS
9+6

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

Course Outcome (CO) For Engineering Mechanics: -

On completion of the course, student will able to-

CO1: Draw free body diagrams and determine the resultant of forces and/or moments.

CO2: Analyse the rigid body in equilibrium.

CO3: Determine the centroid and second moment of area of sections.

CO4: Apply laws of mechanics to determine efficiency of simple machines with consideration of friction.

CO5: Analyse the motion and calculate trajectory characteristics.

CO6: Determine the friction force and the effects by the use of laws of friction, also determine the Rolling resistance and Translation and Rotation of the Rigid Bodies.

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

REFERENCES:

1. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.
2. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.

3. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education 2006.
4. Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley & Sons,1993.
5. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

Paper Name: Engineering Graphics
Code: RB-MS191
Contact Hours/Week: 3P
Credits: 1.5

OBJECTIVES:

1.To present fundamentals of graphics and drafting appropriate for developing functional skill in computer aided drafting.

2. To provide students with adequate knowledge and experience in preparing engineering drawings using AutoCAD

3. To teach students to read, construct and understand basic engineering drawings.

4. To help students acquire the skills pertinent to the production of properly detailed, formatted and dimensioned Engineering drawings.

Sl. No.	Content	Lecture (L)	Practical (P)
1	**INTRODUCTION TO ENGINEERING DRAWING** Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Different types of lines and their use; Drawing standards and codes.	1	4
2	**LETTERING, DIMENSIONING, SCALES** Plain scale, Diagonal scale and Vernier Scales.	1	4
3	**GEOMETRICAL CONSTRUCTION AND CURVES** Construction of polygons, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid, Involute, Archemedian Spiral.	1	4

4	**PROJECTION OF POINTS, LINES, SURFACES** Principles of Orthographic Projections-Conventions - 1st and 3rd angle projection, Projections of Points and lines inclined to both planes; Projections of planes (Rectangle, pentagon, Hexagon etc.) inclined Planes - Auxiliary Planes.	1	4
5	**PROJECTION OF REGULAR SOLIDS** Regular solids inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale (Cube, Pyramid, Prism, Cylinder, Cone).	1	4
6	**COMBINATION OF REGULAR SOLIDS, FLOOR PLANS** Regular solids in mutual contact with each other like Spheres in contact with cones standing on their base. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.	1	4
7	**ISOMETRIC PROJECTIONS** Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;	1	4
8	**SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULAR SOLIDS** Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)	1	4
	OVERVIEW OF COMPUTER GRAPHICS, C**USTOMISATION& CAD DRAWING** listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area		

9	(Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids]; Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;	1	4
10	**ANNOTATIONS, LAYERING & OTHER FUNCTIONS** applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer- aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;	2	8
	DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for		

11	engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).	2	8

Course Outcomes

On completion of the course, student will able to-

CO1: Familiarize with the fundamentals and standards of Engineering graphics

CO2: perform freehand sketching of basic geometrical constructions and multiple views of objects.

CO3: Project orthographic projections of lines and plane surfaces.

CO4: Draw projections and solids and development of surfaces.

CO5: visualize and to project isometric and perspective sections of simple solids.

CO6: Ability to visualize the pictorial view and draw orthographic projection on reference planes including sections by using AutoCAD.

CO7: Ability to draw 2D & 3D Object in Auto CAD.

General Instructions

1. In every topic some problems are to be done in the class and some are to be given to students as home assignment.
2. The problems for class work are to be prepared on drawing sheet of A1 size in the class/ using AutoCAD software.
3. The problems for home assignments are to be prepared on drawing copy/ using AutoCAD software.
4. Print out of every assignment is to be taken for CAD Drawings on Drawing sheets

(A4 Sheets).

5. A title block must be prepared in each sheet/ assignment.

Following is the list of drawing instruments that required for making engineering drawings on paper with perfection.

1. Drawing Board
2. Mini drafter/ Set-squares (45°–45° & 60°–90°), T-square 3. Protractor (180°, 360°)
4. Scales (Plain, Diagonal)
5. Compass (Small and Large)
6. Divider (Small and Large)
7. French Curves
8. Drawing paper (A1 Size)
9. Drawing pencil (H, HB, B)
10. Sharpener
11. Eraser
12. Drawing pins & clips
13. Duster or handkerchief etc.

Communicative English

Code: RB-HU 101
Contact: 3L
Credits: 2
Allotted Hrs: 36

COURSE OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.

- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills

Detailed contents

Unit I: Grammar: Correction of sentence, Vocabulary / word formation, Single word for a group of words, Fill in the blank, transformation of sentences, Structure of sentences – Active / Passive Voice – Direct / Indirect Narration

Unit II: Essay – Descriptive – Comparative – Argumentative – Thesis statement- Structure of opening / concluding paragraphs – Body of the essay

Unit III: Reading Comprehension – Global – Contextual – Inferential – Select passages from recommended text

Unit IV: Business Correspondence – Letter Writing – Formal.Drafting.Biodata- Resume′- Curriculum Vitae

Unit V: Report Writing – Structure , Types of report – Practice Writing

Unit VI: Communication / Public Speaking skills , Features of effective speech, verbal-nonverbal ,Department of Information Technology

Unit VII: Group discussion – principle – practice

Course Outcomes:

On completion of the course, student will able to

CO1: Comprehend conversations and short talks delivered in English

CO2: Write short essays of a general kind and personal letters and emails in English

CO3: Prepare technical reports and short essays.

CO4: Student will able to Learn basic do’s and don’ts of an interview.

CO5: student will able to speak in English.

Reference Books:

1. Mark MaCormack : "Communication"

2. John Metchell" How to write reports"

3. S R Inthira& V Saraswathi" Enrich your English – a) Communication skills b)

Academic

skills " Publisher CIEFL & OUP

4. R.C. Sharma and K.Mohan , "Business Correspondence and Report Writing " , Tata

McGraw Hill , New Delhi , 1994

5. L.Gartside , "Model Business Letters" , Pitman , London , 1992

6. Longman , "Longman Dictionary of Contemporary English" (or 'Oxford Advanced

Learner's Dictionary of Current English' , OUP , 1998.

7. Maxwell Nurnberg and RosenblumMorris , "All About Words" , General Book Depot,

New Delhi , 1995

8. A Text Book for English foe Engineers & Technologists

ENGINEERING MATHEMATICS I

Code:RB-M 101
Contact: 3L+1T
Credits: 3
Allotted Hrs: 36

Aim: The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective realization of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.

Course Objectives:

Course objectives are:

1. To provide knowledge of basic operations of modern algebra and group theory

2. To teach students solving problems involving trigonometric functions

3. Imparting concepts of limit, continuity and differentiability of various functions

4. To teach students solving higher order differentiation

5. Giving knowledge of integration and its applications to find area and volume

6. Imparting knowledge for generating and solving differential equations for practical problems

7. Teaching students concept of imaginary numbers and gives awareness about algebra of complex numbers which helps in understanding of engineering subjects like electrical circuits, Electromagnetic wave theory, and complex analysis etc.

8. To provide knowledge of matrices which is applied for solving system of linear equations and useful in various fields of technology

9. helping students to understand and apply the concept of indeterminate conditions, expansion of standard and non-standard functions in series form

10. To provide the knowledge of probability theories for solving day-to-day problems

11. To teach students various statistical methods for analyzing datasets in the area of engineering and technology

Detailed contents

UNIT I: Modern algebra Binary Operation; Addition Modulo n; Multiplication modulo n; semi group; properties of groups; subgroup.

UNIT II: Trigonometry Radian or circular Measure; Trigonometric Functions; Trigonometric ratios of angle θ when θ is acute; trigonometric ratios of certain standard angles; allied angles; compound angles; multiple and sub- multiple angles.

UNIT III: Limits and Continuity The real number system; The concept of limit; concept of continuity.

UNIT IV: Differentiation Differentiation of powers of x; Differentiation of ex and log x; differentiation of trigonometric functions; Rules for finding derivatives; Different types of differentiation; logarithmic differentiation; differentiation by substitution; differentiation of implicit functions; differentiation from parametric equation. Differentiation from first principles.

UNIT V: Integrations Integration of standard Functions; rules of Integration; More formulas in integration; Definite integrals.

UNIT VI: Differential equations First order differential equations; practical approach to Differential equations; first order and first degree differential equations; homogeneous equations. Linear equations; Bernoulli's equation; Exact Differential Equations.

UNIT VII: Complex Numbers Complex Numbers; Conjugate of a complex number; modulus of a complex Number; geometrical representation of complex number; De Moivere's theorem; nth roots of a complex number.

UNIT VIII: Matrices and Determinants Definition of a matrix; Operations on matrices; Square Matrix and its inverse; determinants; properties of determinants; the inverse of a matrix; solution of equations using matrices and determinants; solving equations using determinants.

UNIT IX: Infinite Series Convergence and divergence; series of positive terms; binomial series; exponential series; logarithmic series.

UNIT X: Probability Concept of probability; sample space and events; three approaches of probability; kolmogorov's axiomatic approach to probability; conditional probability and independence of events; bay's theorem.

UNIT XI: Basics Statistics Measures of central Tendency; Standard Deviation; Discrete series. Methods; Deviation taken from assumed mean; continuous series; combined standard deviation; coefficient of variation; variance.

Course Outcomes:

On completion of the course, student will able to-

CO1: solve problems related to modern algebra and group theory

CO2: apply calculus to solve various engineering problems

CO3: solve practical problems involving differential equations

CO4: solve various problems in the field of engineering and technology using the concepts of

Matrices and Determinants

CO5: find the value of Finite and infinite series and use the Binomial formulae for solving

complex algebraic equations

CO6: use the concepts and theories of probability in day-to-day problems

CO7: perform statistical analysis of various datasets in the area of engineering and Technology

Reference Books:

1. Banerjee A., De S.K. and Sen S.: Mathematical Probability, U.N. Dhur& Sons.

2. Gupta S. C and Kapoor V K: Fundamentals of Mathematical Statistics, Sultan Chand

& Sons.

Learning Resources:

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
6. Corresponding set of CAD Software Theory and User Manuals

Semester-II

DETAILED SYLLABUS

Subject: Analog & Digital Electronics
Code: RBEE201
Contact Hours/week: 3L+1T
Credits: 2
OBJECTIVES:
1. To acquire the basic knowledge of different analog components and their applications

2. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.

3. To prepare students to perform the analysis and design of various digital electronic circuits

UNIT 1 Different Classes of Amplifiers - (Class-A, B, AB and C - basic concepts, power, efficiency; Recapitulation of basic concepts of Feedback and Oscillation, Phase Shift, Wein Bridge oscillators Astable & Monostable Multivibrators; Schimtt Trigger circuits, 555 Timer.

UNIT 2 Binary Number System & Boolean Algebra (recapitulation); BCD, ASCII, EBDIC, Gray codes and their conversions; Signed binary number representation with 1's and 2's complement methods, Binary arithmetic, Venn diagram, Boolean algebra (recapitulation); Representation in SOP and POS forms; Minimization of logic expressions by algebraic method. Combinational circuits - Adder and Subtractor circuits (half & full adder & subtractor); Encoder, Decoder, Comparator, Multiplexer, DeMultiplexer and Parity Generator.

UNIT 3 Sequential Circuits - Basic Flip-flop & Latch, Flip-flops -SR, JK, D, T and JK Master-slave Flip Flops, Registers (SISO, SIPO, PIPO, PISO) Ring counter, Johnson counter Basic concept of Synchronous and Asynchronous counters (detail design of circuits excluded), Design of Mod N Counter

UNIT 4 A/D and D/A conversion techniques – Basic concepts (D/A :R-2-R only [2L] A/D: successive approximation [2L]) Logic families- TTL, ECL, MOS and CMOS - basic concepts. (2L)

Text book and Reference books: 1. Microelectronics Engineering –Sedra & Smith-Oxford. 2. Analog Electronics, A.K. Maini, Khanna Publishing House (AICTE Recommended -2018) 3. Analog Electronics, L.K. Maheswari, Laxmi Publications (AICTE Recommended -2018) 4. Principles of Electronic Devices & circuits—B L Thereja & Sedha—S Chand 5. Digital Electronics – Kharate – Oxford 6. Digital Electronics – Logic & Systems by J.Bigmell & R.Donovan; Cambridge Learning. 7. Digital Logic and State Machine Design (3rd Edition) – D.J.Comer, OUP 8. Electronic Devices & Circuit Theory – Boyelstad & Nashelsky - PHI 9. Bell-Linear IC & OP AMP—Oxford 10. P.Raja- Digital Electronics- Scitech Publications 11. Morries Mano- Digital Logic Design- PHI 12. R.P.Jain—Modern Digital Electronics, 2/e ,McGraw Hill 13. H.Taub & D.Shilling, Digital Integrated Electronics- McGraw Hill. 14. D.RayChaudhuri- Digital Circuits-Vol-I & II, 2/e- Platinum Publishers 15. Tocci, Widmer, Moss- Digital Systems,9/e- Pearson 16. J.Bignell & R.Donovan-Digital Electronics-5/e- Cenage Learning. 17. Leach & Malvino—Digital Principles & Application, 5/e, McGraw Hill 18. Floyed & Jain- Digital Fundamentals-Pearson.

Course Outcomes: On completion of the course students will be able to

ESC-301.1 Realize the basic operations of different analog components.

ESC-301.2 Realize basic gate operations and laws Boolean algebra.

ESC-301.3 Understand basic structure of digital computer, stored program concept and different arithmetic and control unit operations.

Subject: Analog & Digital Electronics Lab
Code: RBEE291
Contact Hours/week: 3L+1T
Credits: 2

Laboratory Experiments:

Analog Electronics

1 Design a Class A amplifier

2 Design a Phase-Shift Oscillator

3 Design of a Schmitt Trigger using 555 timer

Digital Electronics

4 Design a Full Adder using basic gates and verify its output / Design a Full

Subtractor circuit using basic gates and verify its output.

5 Construction of simple Decoder & Multiplexer circuits using logic gates.

6 Realization of RS / JK / D flip flops using logic gates

7 Design of Shift Register using J-K / D Flip Flop

8 Realization of Synchronous Up/Down counter

9 Design of MOD- N Counter

10 Study of DAC

Subject: Strength of Materials for Mechanical Engineers
Code: RB-MS201
Contact Hours/week: 3L+1T
Credits: 2

OBJECTIVES:

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.

- To study the stresses and deformations induced in thin and thick shells.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III TORSION

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV DEFLECTION OF BEAMS

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem.

OUTCOMES

Students will be able to

- Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
- Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
- Apply basic equation of simple torsion in designing of shafts and helical spring
- Calculate the slope and deflection in beams using different methods.
- Analyze and design thin and thick shells for the applied internal and external pressures.

TEXT BOOKS:

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009

REFERENCES:
1. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002
2. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
4. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

Subject: Strength of Materials for Mechanical Engineers Lab
Code: RB-MS291
Contact Hours/week: 3L+1T
Credits: 2

List of Experiments:

1. Tension test on steel rod
2. Compression test on wood
3. Double shear test on metal
4. Torsion test on mild steel rod
5. Impact test on metal specimen (Izod and Charpy)
6. Hardness test on metals (Rockwell and Brinell Hardness Tests)
7. Deflection test on metal beam
8. Compression test on helical spring
9. Deflection test on carriage spring

Subject: Engineering Mathematics - II
Code: RB-M201
Contact Hours/week: 3L+1T
Credits: 3

OBJECTIVES:

This course is designed to cover topics such as Matrix Algebra, Vector Calculus, Complex Analysis and Laplace Transform. Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering. Vector calculus can be widely used for modelling the various laws of physics. The various methods of complex analysis and Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

UNIT I MATRICES

Eigen values and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II VECTOR CALCULUS

Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III ANALYTIC FUNCTIONS

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions 1 2 z z w = z + c, cz, , - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

UNIT V LAPLACE TRANSFORMS

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

OUTCOMES:
After successfully completing the course, the student will have a good understanding of the following topics and their applications:

- Eigen values and eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices.
- Gradient, divergence and curl of a vector point function and related identities.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification. • Analytic functions, conformal mapping and complex integration.
- Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

TEXT BOOKS :
1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.

2. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

REFERENCES:

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi , 3rd Edition, 2007.
3. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.
4. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4 th Edition, New Delhi, 2014.
5. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

Subject: Environmental Science
Code: RB-PR 201
Contact Hours/week: 3L+1T
Credits: 2

OBJECTIVES:

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth‟s interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of

biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organizationenvironmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS

– women and child welfare – role of information technology in environment and human health – Case studies.

OUTCOMES:

- Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.
- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXTBOOKS:

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.

REFERENCES:

1. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) PVT, LTD, Hydrabad, 2015.
3. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
4. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB
(Formerly West Bengal University of Technology)

Syllabus for B. Sc. In Robotics & Robot process automation (RPA) (In-house)
(Effective for Students Admitted in Academic Session 2022-2023)
In CBCS Format

Semester-III

DETAILED SYLLABUS

Subject: Electrical Machines
Code: RBEC301
Contact Hours/week: 3L+1T
Credits: 3

OBJECTIVES:

- To study about basic electrical prime movers, electrical transmission and distribution systems.
- To study about the transformers
- To study about the different types of induction motors
- To study about the special machines
- To study about the power system

UNIT I D.C. MACHINES

Constructional details – EMF equation – methods of excitation – self and separately excited generators – characteristics of series, and shunt generators – principle of operation of D.C. Motor – back emf and torque equation – characteristics of series and shunt motors - starting of D.C. Motors – types of starters - speed control and braking of DC. motors.

UNIT II TRANSFORMERS

Constructional Details – Principle Of Operation – EMF Equation – Transformation Ratio – Transformer on No Load – Parameters Referred To HV/LV Windings – Equivalent Circuit – Transformer on Load – Regulation - Testing – Load Test - 3- PHASE Transformers connections.

UNIT III INDUCTION MOTORS

Construction – types – principle of operation of three-phase induction motors – equivalent circuit – starting and speed control – single-phase induction motors (only qualitative analysis). UNIT IV SYNCHRONOUS AND SPECIAL MACHINES 8 Construction of Synchronous machines-types – induced emf – brushless alternators – reluctance motor – stepper motor servo motor.

UNIT V INTRODUCTION TO POWER SYSTEM

Structure of electric power systems – generation, transmission, sub-transmission and distribution systems - EHVAC and EHVDC transmission systems – substation layout. (Concepts only).

OUTCOMES:

- Understanding the principles of operations and characteristics of DC machines
- Knowledge of electrical transformers and induction motors
- Know about the different types of induction motors
- Able to visualise the operation of synchronous motors stepper and sevo motors.
- Comprehending the power transmission and distributing systems.

TEXT BOOKS :

1. Murugesh Kumar K. , „Electric Machines Vo I", Vikas Publishing House Pvt Ltd, 2010.
2. Murugesh Kumar K. , „Electric Machines Vol II", Vikas Publishing House Pvt Ltd, 2010
3. Mehta V.K. and Rohit Mehta, „Principles of Power System", S.Chand and Company Ltd, 2003

REFERENCES:

1. Fitzgerald A.E., Charles Kingsley, Stephen.D.Umans, „Electric Machinery", Tata McGraw Hill publishing Company Ltd, 2003.
2. Gupta J.B., „Theory and Performance of Electrical Machines", S.K.Kataria and Sons, 2002
3. Kothari D.P. and Nagrath I.J., „Electric Machines", Tata McGraw Hill Publishing Company Ltd, 2002. 4. Bhimbhra P.S. , „Electrical Machinery", Khanna Publishers, 2003.

Subject: Electrical Machines Lab
Code: RB-EE291
Contact Hours/week: 3P
Credits: 2

OBJECTIVES:

- To impart hands on experience in verification of circuit laws and theorems

• To measure the circuit parameters, study of circuit characteristics and simulation of time response. • To expose the students to the basic operation of electrical machines and help them to develop experimental skills.
• To construct Induction Motors with Loading Arrangement
• To verify the circuit laws and theorems and measure the circuit parameters.

LIST OF EXPERIMENTS:
1. Open circuit characteristics of D.C. shunt generator.
2. Load characteristics of D.C. shunt generator.
3. Load test on D.C. shunt motor.
4. Load test on D.C. series motor.
5. Swinburne‟s test
6. speed control of D.C. shunt motor.
7. Load test on single phase transformer
8. open circuit and short circuit tests on single phase transformer(Determination of equivalent circuit parameters).
9. Load test on single phase induction motor.
10. No load and blocked rotor tests on three phase induction motor (Determination of
11. equivalent circuit parameters)
12. Load test on Three phase induction motor.
13. Study of Starters

OUTCOMES:
• Knowledge about the basic operation of electrical machines and help them to develop experimental skills.
• Ability to verify the circuit laws and theorems and measure the circuit parameter.
• Ability to operate electrical machines.
• Ability to construct a Single Phase ,Three Phase Induction Motor with Loading Arrangement and to operate switchs
• Ability to determination the equivalent circuit parameters.

Subject: Microprocessors, Embedded Controllers and Real time Operating Systems
Code: RB-EC301
Contact Hours/week: 3L+1T
Credits: 3

OBJECTIVES:
The student should be made to:
• Study the Architecture of 8085 microprocessor.
• Study the Architecture of 8086 microprocessor.
• Learn the design aspects of I/O and Memory Interfacing circuits.
• Study about communication and bus interfacing.

- Study the Architecture of 8051 microcontroller.

UNIT I 8086 MICROPROCESSOR

Architecture – Pin description – Operating modes – Registers – Interrupts – Bus cycle – Addressing modes – Typical configuration of 8086 system – Overview of Instruction set.

UNIT II 80286 MICROPROCESSOR

Functional block diagram - Modes of operation – Real and protected mode – Memory management and protection features.

UNIT III 80386, 80486 PROCESSORS

80386: Functional block diagram - Programming model - Addressing modes and instruction set overview – Address translation - Modes of operation - 80486 processor - Functional block diagram - Comparison of 80386 and 80486 processors.

UNIT IV PENTIUM MICROPROCESSOR

Introduction – Architecture – Special Pentium registers – Memory management.

UNIT V PIC MICROCONTROLLER

Architecture – Memory structure – Register File – Addressing modes – Interrupts – Timers: Modes of operation PIC PERIPHERAL FUNCTIONS AND SPECIAL FEATURES: PWM output – Analog to Digital converter – UART – Watchdog timer – RESET Alternatives – Power Down mode – I2C Bus operation

OUTCOMES:

At the end of the course, the student should be able to:

- Design and implement programs on 8085 microprocessor.
- Design and implement programs on 8086 microprocessor.
- Design I/O circuits.
- Design Memory Interfacing circuits.
- Design and implement 8051 microcontroller based systems.

TEXT BOOKS:

1. Barry B Brey, "The Intel Microprocessor 8086/8088, 80186/80188, 80286, 80386, 80486 Pentium and Pentium processor, Pentium II,III,4 , Prentice Hall of India, New Delhi, 2005.
2. Douglas V Hall, "Microprocessors and Interfacing: Programming and Hardware", McGraw Hill, New Delhi, 2005.
3. John B Peatman, “Design with PIC Microcontroller, McGraw Hill, Singapore, 1st Reprint, 2001

REFERENCES:

1. Mohammed Rafiquzzaman, "Microprocessors and microcomputer based system design", CRC Press, 2005.
2. Walter A Triebel, Avtar Singh ."The 8088 and 8086 microprocessors Programming Interfacing software, Hardware and Applications",Pearson Education ,2009
3. Myke Pred ko, "Programming and Customising the PIC Microcontroller, "McGraw Hill, USA, 1998

Subject: Microprocessors, Embedded Controllers and Real time Operating Systems lab
Code:
Contact Hours/week: 3P
Credits: 2

List of Experiments:

1. LED Interfacing using ARM/ATMEL/PIC microcontroller
2. LCD Interfacing using ARM/ATMEL/PIC microcontroller
3. Keyboard Interfacing using ARM/ATMEL/PIC microcontroller
4. Temperature sensor Interfacing using ARM/ATMEL/PIC microcontroller
5. Stepper Motor Interfacing using ARM/ATMEL/PIC microcontroller
6. Flashing of LEDs using ARM/ATMEL/PIC microcontroller
7. ADC Interfacing using ARM/ATMEL/PIC microcontroller
8. DAC Interfacing using ARM/ATMEL/PIC microcontroller
9. Interrupt pooling using ARM/ATMEL/PIC microcontroller
10. EPROM Interfacing using ARM/ATMEL/PIC microcontroller.
11. Real Time Clock Interfacing using ARM/ATMEL/PIC microcontroller.
12. Implementing zigbee protocol with ARM/ATMEL/PIC microcontroller.
13. Study of one type of Real Time Operating Systems (RTOS) with ARM/ATMEL/PIC microcontroller.
14. Study of basic image processing algorithm using Single board computers such as Raspberry Pi/aurdino, BeagleBone block etc.

Subject: Kinematics & Dynamics of Machines
Code: RB-MS301
Contact Hours/week: 3L+1T
Credits: 3

OBJECTIVES:

- To understand the basic knowledge about kinematics of machines.

- To understand the basic components and layout of linkages in the assembly of a system/ machine. • To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.

UNIT I KINEMATIC OF MACHINES

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons – Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

UNIT II GEARS and GEAR TRAINS

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

UNIT III FRICTION

Sliding and Rolling Friction angle – friction in threads – Friction Drives –Belt and rope drives .

UNIT IV FORCE ANALYSIS

Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D‟Alembert‟s principle – superposition principle – dynamic Force Analysis in simple machine members.

UNIT V BALANCING AND VIBRATION

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft .

OUTCOMES:

Upon completion of this course,

- the students be able to understand the basic knowledge of kinematics of machines
- Students can able to apply fundamentals of mechanism for the design of new mechanisms
- Able to know about the linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- Impart knowledge about the gears and gear trains.

- Ability to analyse them for optimum design.

TEXT BOOKS:

1. Ambekar A.G., "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007
2. Shigley J.E., Pennock G.R and Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press, 2003

REFERENCES:

1. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
2. Ghosh. A, and A.K. Mallick, "Theory and Machine", Affiliated East-West Pvt. Ltd., New Delhi, 1988. 3. Rao.J.S. and Dukkipatti R.V. "Mechanisms and Machines", Wiley-Eastern Ltd., New Delhi, 1992.
4. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low Prices Student Edition, 1999. 5. V.Ramamurthi, Mechanisms of Machine, Narosa Publishing House, 2002.
6. Robert L.Norton, Design of Machinery, McGraw-Hill, 2004.

Subject: Kinematics & Dynamics Lab
Code: RB-MS 391
Contact Hours/week: 3P
Credits: 1.5

OBJECTIVES:

• To supplement the principles learnt in kinematics and Dynamics of Machinery.
• To understand how certain measuring devices are used for dynamic testing.

LIST OF EXPERIMENTS

1. a) Study of gear parameters. b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.

2. a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms. b) Kinematics of single and double universal joints.

3. a) Determination of Mass moment of inertia of Fly wheel and Axle system. b) Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus. c) Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.

4. Motorized gyroscope – Study of gyroscopic effect and couple.

5. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.

6. Cams – Cam profile drawing, Motion curves and study of jump phenomenon

7. a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination. b) Multi degree freedom suspension system – Determination of influence coefficient.

8. a)Determination of torsional natural frequency of single and Double Rotor systems.- Undamped and Damped Natural frequencies. b) Vibration Absorber – Tuned vibration absorber.

9. Vibration of Equivalent Spring mass system – undamped and damped vibration.

10. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.

11. a) Balancing of rotating masses. (b) Balancing of reciprocating masses.

12. a) Transverse vibration of Free-Free beam – with and without concentrated masses. b) Forced Vibration of Cantilever beam – Mode shapes and natural frequencies. c) Determination of transmissibility ratio using vibrating table.

OUTCOMES:
- Ability to demonstrate the principles of kinematics and dynamics of machinery
- Ability to use the measuring devices for dynamic testing.

Subject: Digital Signal Processing
Code: RBPH301
Contact Hours/week: 3L+1T
Credits: 2

OBJECTIVES:
- To understand the concept of information, types of channels
- To understand the capabilities of various source coding theorems and the fundamental limit of transmission over the channel.
- To understand the various concepts of signal processing with its applications.
- To understand the capabilities of various channel coding theorems.
- To develop the knowledge on pass band communication and spread spectrum.

UNIT I ARCHITECTURE OFTMS320C5X

Introduction -Bus structure-Central Arithmetic Logic unit(CALU)-Auxiliary Register ALU(ARAU)-Index register(INDX)-Auxiliary register compare register-Block move address register-,Block repeat registers-parallel logic unit-memory mapped registers-program controllers-on chip features.

UNIT II TMS320C5X PROGRAMMING

Assembly language syntax-Addressing modes, Load/store instructions-Addition/subtraction instructions-Move instructions-Multiplication instruction-NORM instruction-Program control instructions-Peripheral instructions-Instruction Pipelining inC5x-Pipeline structure, Pipeline operationNormal pipeline Operation.

UNIT III APPLICATIONS

C50 based starter kit-Programs for familiarization of the addressing modes-Program for familiarization of Arithmetic Instructions-Programs in C5x for Processing Real time signals.

UNIT IV ARCHITECTURE OF TMS320C54X

Introduction-Architecture-Buses-Memory Organization-CPU-ALU-Barrel shifter-Multiplier/Adder unitCompare, Select and store unit-Exponent Encoder-C54X pipeline-On chip Peripherals-Data Address Generation logic-Program address generation logic.

UNIT V TMS320C54X PROGRAMMING

Data Addressing-Arithmetic instructions-Move instructions-Load/Store instructions-Logical instructions-Control instructions-Conditional store instructions-Repeat instructions-I/o instructions-Bit manipulation instructions-parallel instructions-special instructions-Application programs.

OUTCOMES: Upon completion of the course, students will be able to

- Know about the various concepts of signal processing with its applications
- Discuss the representation of signals and the process of sampling, quantization and coding that are fundamental to the digital transmission of analog signals.
- Know about the capabilities of various source coding theorems and the fundamental limit of transmission over the channel.
- Design the baseband and band pass signal transmission and reception techniques.
- Explain error control coding which encompasses techniques for the encoding and decoding of digital data streams for their reliable transmission over noisy channels.

TEXT BOOK: 1. Venkataramani B., Bhaskar M. ”Digital Signal Processors: Architecture, Programming and Applications “Tata McGraw Hill, 2008

REFERENCES:

1. Sem.M.Kuo Woon-Seng.s.Gan “Digital Signal Processors: Architectures, Implementations, and Applications “Pearson Education,2005.
2. Steven W smith “Scientist and Engineer‟s Guide to Digital signal processing”, 200

Subject: DSP Lab
Code: RBPHT301
Contact Hours/week:

Credits: 2

Sampling and data reconstruction process. Z transforms.

Discrete linear systems. Frequency domain design of digital filters.

Quantization effects in digital filters.

Discrete Fourier transform and FFT algorithms.

High Speed convolution and its applications to digital filtering. Multi-rate filtering.

Suggested Text Books & References

Rabiner, L.R. & Gold, B., "Theory and Application of Digital signal Processing", Prentice Hall, 1989. Oppenheim & Schafer, "Digital Signal Processing", Prentice Hall, 1995.

Subject: Introduction to python

Code: RBCS301

Contact Hours/week:
Credits: 2

UNIT 1: Motivation for Computing
UNIT 2: Welcome to Programming!!
UNIT 3: Variables and Expressions : Design your own calculator
UNIT 4: Loops and Conditionals : Hopscotch once again
UNIT 5: Lists, Tuples and Conditionals : Lets go on a trip
UNIT 6: Abstraction Everywhere : Apps in your phone
UNIT 7: Counting Candies : Crowd to the rescue
UNIT 8: Birthday Paradox : Find your twin
UNIT 9: Google Translate : Speak in any Language
UNIT10: Currency Converter : Count your foreign trip expenses
UNIT 11: Monte Hall : 3 doors and a twist
UNIT 12: Sorting : Arrange the book

Semester-IV

Subject: Power Electronics and Drives
Code: RB-EE401

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB
(Formerly West Bengal University of Technology)

Syllabus for B. Sc. In Robotics & Robot process automation (RPA) (In-house)
(Effective for Students Admitted in Academic Session 2022-2023)
In CBCS Format

Contact Hours/week: 3L+1T
Credits: 3

OBJECTIVES

- Comprehensive introduction to various power electronic devices, their structure, operating principle and characteristics
- Give exposure to Various topologies, working principle and analysis of controlled rectifiers and ac controllers
- Detailed knowledge on Classifications, structure, operating principle of dc choppers
- Introduction to different types of Inverters , their principle of operation and waveform control
- Overview on dc and ac drives and their control using power electronic circuits.

UNIT I POWER SEMICONDUCTOR DEVICES AND CHARACTERISTICS

Operating principle and switching Characteristics: Power diodes, Power BJT, Power MOSFET, IGBT, SCR, TRIAC, GTO, MCT, Power integrated circuits (PIC) – Drive and Protection circuits – Series and parallel operation – Commutation – Simulation tools.

UNIT II CONTROLLED RECTIFIERS AND AC CONTROLLERS

Single phase – Three phase – Half controlled – Fully controlled rectifiers – Dual converters - Effect of source and load inductance - AC voltage controllers –Introduction to Cycloconverters, Matrix converters.

UNIT III DC TO DC CONVERTERS

Step up and Step down Chopper – Chopper classification - quadrant of operation – Switching mode Regulators – Buck, Boost, Buck-Boost, and Cuk Regulators.

UNIT IV INVERTERS

Voltage source Inverters – Half bridge – Full bridge – Three Phase Bridge Inverters – Voltage control– PWM Techniques – Current Source Inverters: Capacitor Commutated Inverter- Resonant inverters: Series, Parallel, ZVS, ZCS – Introduction to multilevel Inverters.

UNIT V DRIVES AND CONTROL

Static and Dynamic equations of dc and ac machines – Electrical breaking – Rectifier and chopper control of DC drives – Principles of v/f control of AC drives – Open loop and Closed loop schemes for DC and AC drives(Block diagram approach only) – Introduction to vector control of AC drives.

COURSE OUTCOMES (COs)

1. Ability to explain various devices and their structure, operating characteristics in the field of electronics.

2. Ability to classify, analyze and design, Control rectifier, chopper and inverter.
3. Will have ability to apply power electronic circuits for the control of popular applications.
4. Exposure to design and analyze PE circuit using simulation software.

TEXT BOOKS:

1. Rashid, M.H., "Power Electronics – Circuits, Devices and Applications", PHI, 3rd Edition, 2004.
2. Mohan, Udeland and Robbins., "Power Electronics", John Wiley and Sons, New York, 1995.

REFERENCES:

1. Singh, M.D., and Khanchandani, K.B., "Power Electronics", 2nd Edition., Tata McGraw-Hill, 2011.
2. Bose, B.K., "Modern Power Electronics and AC Drives", Pearson Education, 2002.
3. Bimbra, P.S., "Power Electronics", Khanna Publishers, 2006.
4. Moorthi, V.R., "Power Electronics - Devices, Circuits and Industrial Applications", Oxford University Press, 2005.
5. NPTEL Lecture Series on "Power Electronics" by Dr.B.G.Fernandes, IIT Bombay.

Subject: Power Electronics & Drives Lab
Code: RB-EE491
Contact Hours/week: 3P
Credits: 2

OBJECTIVES:

- To provide hands on experience with power electronic converters and testing.

LIST OF EXPERIMENTS

1 Gate Pulse Generation using R, RC and UJT.
2 Characteristics of SCR and TRIAC
3 Characteristics of MOSFET and IGBT
4 AC to DC half controlled converter
5 AC to DC fully controlled Converter
6 Step down and step up MOSFET based choppers
7 IGBT based single phase PWM inverter
8 IGBT based three phase PWM inverter
9 AC Voltage controller
10 Switched mode power converter.
11 Simulation of PE circuits (1Φ & 3Φ semi converters, 1Φ & 3Φ full converters, DC-DC converters, AC voltage controllers).

12 Characteristics of GTO & IGCT.
13 Characteristics of PMBLDC motor

OUTCOMES:

- Ability to practice and understand converter and inverter circuits and apply software for engineering problems.
- Ability to experiment about switching characteristics various switches.
- Ability to analyze about AC to DC converter circuits.
- Ability to analyze about DC to AC circuits.
- Ability to acquire knowledge on AC to AC converters
- Ability to acquire knowledge on simulation software.

Subject: Sensors and Instrumentation
Code: RB-EC401
Contact Hours/week: 3L+1T
Credits: 2

OBJECTIVES:

- To understand the concepts of measurement technology.
- To learn the various sensors used to measure various physical parameters.
- To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.

UNIT I INTRODUCTION

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers. UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS 11 Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD,

Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

OUTCOMES:
Upon Completion of the course the students will be able to
CO1: Familiar with various calibration techniques and signal types for sensors.
CO2: Apply the various sensors in the Automotive and Mechatronics applications
CO3: Describe the working principle and characteristics of force, magnetic and heading sensors.
CO4: Understand the basic principles of various pressure and temperature, smart sensors.
CO5: Ability to implement the DAQ systems with different sensors for real time applications.

TEXT BOOKS:

1.Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009 2.Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES

1.C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001
2.Hans Kurt Tönshoff (Editor), Ichiro , “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
3.John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
4.Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
5.Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015

Subject: Sensors & Instrumentation Lab
Code: RB-EC491
Contact Hours/week: 3P
Credits: 1.5
Laboratory Experiments :

1 Temperature measurement using AD590 IC sensor.

2 Displacement measurement by using a capacitive transducer.

3 Pressure and displacement measurement by using LVDT.

4 Study of a load cell with tensile and compressive load.

5 Torque measurement Strain gauge transducer.

6 Speed measurement using magnetic proximity sensor.

7 Speed measurement using a Stroboscope.

8 Study of the characteristics of a LDR.

9 Mandatory Design and Implementation of Mini Project

Subject: Principles of Robotics I
Code: RBPR401
Contact Hours/week: 3L+1T
Credits: 3

OBJECTIVES:

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulators

UNIT I BASIC CONCEPTS

Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and controlissues- Various manipulators – Sensors - work cell - Programming languages.

UNIT II DIRECT AND INVERSE KINEMATICS

Mathematical representation of Robots - Position and orientation – Homogeneous transformationVarious joints- Representation using the Denavit Hattenberg parameters - Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.

UNIT III MANIPULATOR DIFFERENTIAL MOTION AND STATICS

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse - Wrist and arm singularity - Static analysis - Force and moment Balance.

UNIT IV PATH PLANNING

Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.

UNIT V DYNAMICS AND CONTROL

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

UNIT VI INTRODUCTION TO ROBOTIC PROCESS AUTOMATION & BOT CREATION

Introduction to RPA and Use cases – Automation Anywhere Enterprise Platform – Advanced features and capabilities – Ways to create Bots – Conclusion.

UNIT VII WEB CONTROL ROOM AND CLIENT

Introduction - Features Panel - Dashboard (Home, Bots, Devices, Audit, Workload, Insights) - Features Panel – Activity (View Tasks in Progress and Scheduled Tasks) - Bots (View Bots Uploaded and Credentials) - Devices (View Development and Runtime Clients and Device Pools) - Workload (Queues and SLA Calculator) - Audit Log (View Activities Logged which are associated with Web CR) - Administration (Configure Settings, Users, Roles, License and Migration) - Demo of Exposed API's – Conclusion – Client introduction and Conclusion.

OUTCOMES:

- Ability to understand basic concept of robotics.
- To analyze Instrumentation systems and their applications to various
- To know about the differential motion add statics in robotics
- To know about the various path planning techniques.
- To know about the dynamics and control in robotics industries.

TEXT BOOKS:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005. 2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 3. 2009.
3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
4. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath: Create Software robots. with the leading RPA tool – UiPath Kindle Edition
5. Robotic Process Automation A Complete Guide - 2020 Edition Kindle Editio

REFERENCES:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.

5. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.
6. S.Ghoshal, " Embedded Systems & Robotics" – Projects using the 8051 Microcontroller", Cengage Learning, 2009.

Subject: Principle Robotics Lab I
Code: RBPR491
Contact Hours/week: 3P
Credits: 1.5

OBJECTIVES:
- To introduce different types of robotics and demonstrate them to identify different parts and components.
- To write programming for simple operations.

LIST OF EXPERIMENTS
1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system 3. Estimation of accuracy, repeatability and resolution.
4. Robot programming and simulation for pick and place
5. Robot programming and simulation for Colour identification
6. Robot programming and simulation for Shape identification
7. Robot programming and simulation for machining (cutting, welding)
8. Robot programming and simulation for writing practice
9. Robot programming and simulation for any industrial process (Packaging, Assembly)
10. Robot programming and simulation for multi process.

OUTCOME:
Upon Completion of the course, the students will be able to:
CO1:Use of any robotic simulation software to model the different types of robots and calculate work volume for different robots

Subject: Values & Ethics*
Code: RB-HU601
Contact Hours/week: 3L
Credits: 3

OBJECTIVE: • To enable the students to create an awareness on Engineering Ethics and Human Values to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

OUTCOME: • Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

TEXT BOOKS: 1. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004. 2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.

REFERENCES: 1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004. 2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009. 3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003 4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001. 5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013. 6. World Community Service Centre, ' Value Education', Vethathiri publications, Erode, 2011.

Web sources: 1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

* **Course to be completed from MOOCs Platform.**

Subject: Machine Learning,*
Code:
Contact Hours/week: 3L
Credits: 3
UNIT I-Introduction: Basic denitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation.
UNIT 2-Linear regression, Decision trees, overtting.
UNIT 3-Instance based learning, Feature reduction, Collaborative ltering based recommendation.
UNIT 4- Probability and Bayes learning.
UNIT 5- Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM.
UNIT 6- Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network.
UNIT 7- Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning.
UNIT 8- Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model.

Semester-V

Subject: Control System
Code: RB-EE501
Contact Hours/week: 3L+1T
Credits: 3

OBJECTIVES:
- To study the basics of control system and its response .stability of mechanical and electrical systems . Use of MATLAB to design a stable control system.
- To introduce the elements of control system and their modeling using various Techniques.
- To introduce methods for analyzing the time response.
- To impart knowledge about the frequency response and the stability of systems
- To introduce the state variable analysis method

UNIT I INTRODUCTION

Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function - Modeling of physical systems – Mechanical, Thermal, Hydraulic systems and Electric Networks - Transfer function of DC generator, DC servomotor, AC servomotor

,Potentiometer, Synchros, Tachogenerator, Stepper motor - Block diagram - reduction techniques, Signal flow graph – Mason‟ gain formula. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT II TIME DOMAIN ANALYSIS

Standard Test signals – Time response of second order system - Time domain specifications - Types of systems - Steady state error constants - Introduction to P, PI and PID modes of feed back control. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT III FREQUENCY DOMAIN ANALYSIS

Frequency domain specifications - Time and frequency response correlation – Polar plot – Bode plot – All pass minimum phase and non-minimum phase systems. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT IV SYSTEM STABILITY

Characteristic equation - Routh Hurwitz criterion of stability - Absolute and Relative stability - Nyquist stability - Nyquist stability criterion - Assessment of relative stability – Gain and Phase Margin. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT V ROOT LOCUS METHOD

Root locus concepts - Construction of root loci – Root contours. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions) STATE SPACE ANALYSIS: Limitations of conventional control theory - Concepts of state, state variables and state model – state model for linear time invariant systems - Introduction to state space representation using physical - Phase and canonical variables. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

OUTCOMES:

- To understand the basic of the control system
- Ability to know about the time and frequency domain analysis
- To know about the different stability of the systems
- To expose students to the state space representation and its analysis.
- To introduce non-linear systems and their control and to impart knowledge on advanced control techniques

TEXT BOOKS:

1. Nagrath I J, and Gopal, M, 'Control Systems Engineering" Prentice Hall of India, New Delhi, 2008.
2. Richard C Dorf and Robert H Bishop, "Modern Control Systems.", Addison-Wesley -2007

REFERENCES:

1. Ogata K, "Modern Control Engineering", Pearson Education, New Delhi, 2006.

2. Kuo B C, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.
3. Norman C. Nise S, "Control system Engineering", John Wiley & Sons, Singapore, 2004.

Subject: Control System Lab
Code: RB-EE591
Contact Hours/week: 3L+1T
Credits: 3
Laboratory Experiments:

1. Familiarization with MAT-Lab control system tool box, MAT-Lab- simulink tool box & PSPICE
2. Determination of Step response for first order & Second order system with unity feedback with the help of CRO &calculation of control system specification , Time constant, % peak overshoot, settling time etc. from the response.
3. Simulation of Step response & Impulse response for type-0, type-1 & Type-2 system with unity feedback using MATLAB & PSPICE.
4. Determination of Root locus, Bode plot, Nyquist plot using MATLAB control system tool box for 2nd order system & determination of different control system specification from the plot.
5. Determination of PI, PD and PID controller action of first order simulated process.
6. Determination of approximate transfer functions experimentally from Bode plot.
7. Evaluation of steady state error, setting time , percentage peak overshoot, gain margin, phase margin with addition of Lead, Lag, Lead-lag compensator.
8. Study of a practical position control system obtaining closed step responses for gain setting corresponding to over-damped and under-damped responses. Determination of rise time and peak time using individualized components by simulation. Determination of un-damped natural frequency and damping ration from experimental data.
9. Design of Lead, Lag and Lead-Lag compensation circuit for the given plant transfer function. Analyze step response of the system by simulation.
10. Determination of Transfer Function of a given system from State Variable model and vice versa. Analysis of a physical system by State variable and to obtain step response for the system by simulation.
11. Study of State variable analysis using simulation tools. To obtain step response and initial condition response for a single input, two-output system in SV form by simulation.

Institute may develop experiments based on the theory taught in addition to experiments mentioned.

Course outcome: After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment.
2. test the instrument for application to the experiment.
3. construct circuits with appropriate instruments and safety precautions.
4. use MAT-Lab control system tool box, MAT-Lab- simulink tool box & PSPICE for simulation of systems.
5. determinecontrol system specifications of first and second order systems.

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB
(Formerly West Bengal University of Technology)

Syllabus for B. Sc. In Robotics & Robot process automation (RPA) (In-house)
(Effective for Students Admitted in Academic Session 2022-2023)
In CBCS Format

Subject: Introduction to Robotics II
Code: RB-PR501
Contact Hours/week: 3L+1T
Credits: 3

OBJECTIVES:

- To study the various parts of robots and fields of robotics.
- To study the various kinematics and inverse kinematics of robots.
- To study about the localization, planning and navigation.
- To study the control of robots for some specific applications.
- To study about the humanoid robots.

UNIT I INTRODUCTION

History of service robotics – Present status and future trends – Need for service robots - applicationsexamples and Specifications of service and field Robots. Non conventional Industrial robots.

UNIT II LOCALIZATION

Introduction-Challenges of Localization- Map Representation- Probabilistic Map based LocalizationMonte carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems- Route based localization.

UNIT III PLANNING AND NAVIGATION

Introduction-Path planning overview- Road map path planning- Cell decomposition path planningPotential field path planning-Obstacle avoidance - Case studies: tiered robot architectures. UNIT IV FIELD ROBOTS 9 Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications.

UNIT V HUMANOIDS:

Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications, Case studies.

UNIT VI BOT CREATOR

Introduction – Recorders – Smart Recorders – Web Recorders – Screen Recorders - Task Editor – Variables - Command Library – Loop Command – Excel Command – Database Command - String Operation Command - XML Command - Terminal Emulator Command - PDF Integration Command - FTP Command - PGP Command - Object Cloning Command -

Error Handling Command - Manage Windows Control Command - Workflow Designer - Report Designer - Best Practices – Summary

UNIT VII META BOT AND BOT INSIGHT

Introduction - MetaBot Designer - MetaBot With AI Sense - Bot Insight -Transactional Analytics - Operational Analytics - Course Key Points.

OUTCOMES: Upon completion of the course, the student should be able to: • Explain the basic concepts of working of robot • Analyze the function of sensors in the robot • Write program to use a robot for a typical application • Use Robots in different applications • Know about the humanoid robots.

TEXT BOOKS: 1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2004

2. Riadh Siaer, „The future of Humanoid Robots- Research and applications", Intech Publications, 2012.

3. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath: Create Software robots. with the leading RPA tool – UiPath Kindle Edition

4. Robotic Process Automation A Complete Guide - 2020 Edition Kindle Editio

REFERENCES: 1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006. 2. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011

Subject: Introduction to Robotics II Lab
Code: RB-PR591
Contact Hours/week: 3P
Credits: 2
LIST OF PRACTICALS

- Bot Creation using recorders (Smart, Web and Screen).
- Bot Creation using command library – (Loop Command).
- Bot Creation to invoke database automation
- Bot Creation for automating excel operations
- Bot Creation for PDF Integrations.
- Bot Creation and working on error handling.
- Bot Development using Object Cloning Command.

- FTP and PGB Command Execution by Bots
- MetaBot Designing with AI Sense.

Subject: Industrial Design & Applied Ergonomics
Code: RB-PR502
Contact Hours/week: 3L+1T
Credits: 2

OBJECTIVES:

- To explain the general principles that governs the interaction of humans in their working environment
- To improve improving worker performance and safety.

- To know about the environmental conditions in the industry.
- To know about bio thermodynamics and bioenergetics
- To know about the human factors in industrial aspects

UNIT I INTRODUCTION

Definition, human technological system, multidisciplinary engineering approach, human–machine system, manual, mechanical, automated system, human system reliability, conceptual design, advanced development, detailed design and development. INFORMATION INPUT: Input and processing, text, graphics, symbols, codes, visual display of dynamic information, auditory, tactual, olfactory displays, speech communications.

UNIT II HUMAN OUTPUT AND CONTROL

Physical work, manual material handling, motor skill, human control of systems, controls and data entry devices, hand tools and devices. WORKPLACE DESIGN: Applied anthropometry, workspace design and seating, arrangement of components within a physical space, interpersonal aspects of work place design, design of repetitive task, design of manual handling task, work capacity, stress, and fatigue.

UNIT III ENVIRONMENTAL CONDITIONS

Illumination, climate, noise, motion, sound, vibration, colour and aesthetic concepts. BIOMECHANICS: Biostatic mechanics, statics of rigid bodies, biodynamic mechanics, human body kinematics, kinetics, impact and collision.

UNIT IV BIOTHERMODYNAMICS AND BIOENERGETICS

Biothermal fundamentals, human operator heat transfer, human system bioenergetics, thermoregulatory physiology, human operator thermo regularity, passive operator, active operator, heat stress.

UNIT V HUMAN FACTORS APPLICATIONS

Human error, accidents, human factors and the automobile, organizational and social aspects, steps according to ISO/DIS6385, OSHA‟s approach, virtual environments.

OUTCOMES:

The Student should

- Know about ergonomic principles to design workplaces
- improve human performance • judge the environmental conditions in the work place.
- know about biothermodynamics and bioenergetics
- implement latest occupational health and safety to the work place.

TEXT BOOK:

1. Chandler Allen Phillips, “Human Factors Engineering”, John Wiley and Sons, New York, 2000.

REFERENCES:

1. Bridger R S, “Introduction to Ergonomics”, Taylor and Francis, London, 2003.
2. Mayall W H, “Indus trial Design for Engineers”, London ILIFFEE Books Ltd., UK, 1998.
3. Mark S Sanders, “Human Factors in Engineering and Design”, McGraw Hill, New York, 1993.

Subject: Industrial Design & Applied Ergonomics Lab
Code: RB-PR592
Contact Hours/week: 3L+1T
Credits: 2

List of Experiments:

1. Measure Anthropometric Dimensions of a group of Human Subjects and express the Data in percentile
2. Design a Biomechanical Model based on Anthropometric Dimensions of Human subject
3. Estimate Manual Material Handling Capacity of a group of Human Subjects using Biomechanical Model
4. Estimate Manual Material Handling Capacity of a group of Human Subjects using Psychophysical Methodology
5. Record Heart Beat, Pressure and ECG data for few subjects for a manual task and analyse the data.
6. Design a Robotic Grip using Biomechanical insight of Human Fingures.

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In CBCS Format

Subject: Mechanical design
Code: RB-MS 501
Contact Hours/week: 3L+1T
Credits: 2

Module 1: Introduction to Mechanical Engineering Design- Review of models of Solid mechanics,
uncertainties in design equations and factor of safety. Role of off the shelf available machine elements and standards. Standard numbering system including BIS designations of materials. Application of theories of failure to design
Module 2: Design procedure and applications of Statically Loaded Machine Elements- Design of
elements subjected to simple loading: Riveted joints, Screws including power screws Bolted joints
including eccentrically loaded joints, Axles, and coupling, Clutches and brakes.
Module 3: Fatigue- Introduction to design for fatigue strength. Endurance and modifying factors.
Surface strength. Review of design procedure of fatigue failure with application to the design of
bolts and springs subjected to fatigue loading.
Module 4: Design procedure and applications of Dynamically Loaded Machine Elements. Shafts,
Spur, helical, bevel and worm gears, Journal and rolling contact bearings, Belts and chains. Assemblies of various machine elements like those of a screw jack and a gear box.
Text/Reference Books:
1. Budynas, R. G., & Nisbett, J. K.. Shigley's mechanical engineering design: McGraw-Hill.
2. Norton, R. L. Machine design: an integrated approach: Prentice Hall
3. Spotts, M. F., Shoup, T. E., & Hornberger, L. E. Design of machine elements: Pearson /Prentice Hall
4. Hamrock,B.J. et.al., Fundamentals of Machine Elements, McGraw Hill86
5. Bhandari, V. B. Design of Machine Elements: McGraw-Hill Education (India) Pvt Ltd.
6. Juvinall, R. C., & Marshek, K. M. Fundamentals of machine component design: John Wiley.
7. NPTEL courses: http://nptel.iitm.ac.in/courses.php - web and video resources on Dynamics of Mechanical
System/ Design of Machine Elements /Machine Design.

Subject: Mechanical design Lab
Code: RB-MS 591
Contact Hours/week: 3L+1T
Credits: 2

OBJECTIVE: • The main objective is to give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them.
GUIDELINE FOR REVIEW AND EVALUATION The students may be grouped into 2 to 4 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department. TOTAL : 60 PERIODS
OUTCOMES: Upon the completion of this course the students will be able to
CO1 design and Fabricate the machine element or the mechanical product.
CO2 demonstrate the working model of the machine element or the mechanical product.

Semester-VI

Subject: 3D Printing
Code: RB-PR503
Contact Hours/week: 3L+1T
Credits: 2

PRE-REQUISITES
- Computer Aided Design
- Engineering Materials

OBJECTIVES
The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0
environment.
LEARNING OUTCOMES
After completion of this course, the students will be able to:
- Develop CAD models for 3D printing.
- Import and Export CAD data and generate .stl file.
- Select a specific material for the given application.
- Select a 3D printing process for an application.
- Produce a product using 3D Printing or Additive Manufacturing (AM).

DETAIL CONTENTS
1. 3D Printing (Additive Manufacturing) (3 Hours)
Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing

processes, Applications.
2. CAD for Additive Manufacturing (4 Hours)
CAD Data formats, Data translation, Data loss, STL format.
3. Additive Manufacturing Techniques (12 Hours)
3.1 Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.

3.2 Process, Process parameter, Process Selection for various applications.
3.3 Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools
4. Materials (8 Hours)
4.1 Polymers, Metals, Non-Metals, Ceramics
4.2 Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.
4.3 Support Materials
5. Additive Manufacturing Equipment (10 Hours)
5.1 Process Equipment- Design and process parameters
5.2 Governing Bonding Mechanism
5.3 Common faults and troubleshooting
5.4 Process Design
6. Post Processing: Requirement and Techniques (4 Hours)
7. Product Quality (4 Hours)
7.1 Inspection and testing
7.2 Defects and their cause

Subject: 3D Printing Lab
Code: RBPR691
Contact Hours/week: 3P
Credits: 2
LIST OF PRACTICALS
1. 3D Modelling of a single component.
2. Assembly of CAD modelled Components
3. Exercise on CAD Data Exchange.
4. Generation of .stl files.
5. Identification of a product for Additive Manufacturing and its AM process plan.
6. Printing of identified product on an available AM machine.
7. Post processing of additively manufactured product.
8. Inspection and defect analysis of the additively manufactured product.
9. Comparison of Additively manufactured product with conventional manufactured counterpart.

10. Software Installation Procedure – Installation of AA Control Room, SQL Server and AA Client.

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Subject: Machine Vision
Code: RB-CS601
Contact Hours/week: 3L+1T
Credits: 3

OBJECTIVES:

- To know about the principles and applications of vision system in modern manufacturing environment
- To learn about the algorithms in vision
- To know about the recognition of object
- To be familiar about the applications regarding vision
- To know about the components used for vision

UNIT I VISION SYSTEM

Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interfaces

UNIT II VISION ALGORITHMS

Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.

UNIT III OBJECT RECOGNITION

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values.

UNIT IV APPLICATIONS

Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.

UNIT V ROBOT VISION

Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV - The cv_bridge Package.

OUTCOMES:

- Knowledge or gadgets of vision systems
- Ability to understand the image capturing and processing techniques
- Ability to apply the vision system in other machines
- Knowledge for recognizing the objects.
- Knowledge in application of vision and image processing in robot operations.

TEXT BOOKS:

1. Carsten Steger, Markus Ulrich, Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY-VCH, Weinheim,2008.
2. Damian m Lyons,"Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011.

REFERENCES:

1. Rafael C. Gonzalez and Richard E.woods, "Digital Image Processing", Addition - Wesley Publishing Company, New Delhi, 2007.
2. Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2000.
3. R.Patrick Goebel, " ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I", A Pi Robot Production, 2012.

Subject: Machine Vision Lab
Code: RB-CS691
Contact Hours/week: 3L+1T
Credits: 3

Experiments:

1. Train a semantic segmentation network using Deep Learning
2. Estimate 3D structure of a scene from 2D image
3. Combine multiple 3-point clouds to reconcile a 3D scene using iterative closest point (ICP) algorithm
4. Measure the diameter of Coins in world units using a single calibrated camera
5. Automatically determine the geometric transformation between a pair of images.
6. Perform automatic detection and motion-based tracking of moving objects in a video from a stationary camera.
7. Automatically create a panorama using feature-based image registration technique.

Subject: Internet of things*
Code: RBCS602
Contact Hours/week: 3L+1T
Credits: 3

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***Course to be completed from MOOCs Platform.**

UNIT1: Introduction: Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II
UNIT 2: Industry 4.0: Globalization, The Fourth Revolution, LEAN Production Systems
UNIT 3: Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform
and Product Lifecycle Management
UNIT 4: Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Part II,
Industrial Sensing & Actuation
UNIT 5: IIoT-Introduction, Industrial IoT: Business Model and Referece Architerture: IIoT-Business
Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II.
UNIT 6: Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing-Part I, Part II, IIoT
Communication-Part I.
UNIT 7: Industrial IoT- Layers: IIoT Communication , IIoT Networking-Part I, Part II, Part III.
UNIT 8: Industrial IoT: Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction,Machine Learning and Data Science
UNIT 9: Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT-Part I, Part II,
Data Center Networks, Industrial IoT
UNIT 10: Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT-Part I,
Part II, Industrial IoT- Application Domains
UNIT 11: Industrial IoT- Application Domains: Healthcare, Power Plants
UNIT 12: Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studie

Subject: Internet of things Lab
Code: RBCS692
Contact Hours/week: 3L+1T
Credits: 3
List of Experiments:
1. Functional Testing Of Devices
Flashing the OS on to the device into a stable functional state by porting desktop environment with necessary packages.
2. Exporting Display On To Other Systems Making use of available laptop/desktop displays as a display for the device using SSH client & X11 display server.

3. GPIO Programming Programming of available GPIO pins of the corresponding device using native programming language. Interfacing of I/O devices like LED/Switch etc., and testing the functionality.
4. Interfacing Chronos eZ430 Chronos device is a programmable texas instruments watch which can be used for multiple purposes like PPT control, Mouse operations etc., Exploit the features of the device by interfacing with devices.
5. ON/OFF Control Based On Light Intensity Using the light sensors, monitor the surrounding light intensity & automatically turn ON/OFF the high
intensity LED's by taking some pre-defined threshold light intensity value.
6. Battery Voltage Range Indicator Monitor the voltage level of the battery and indicating the same using multiple LED's (for ex: for 3V battery and 3 led's, turn on 3 led's for 2-3V, 2 led's for 1-2V, 1 led for 0.1-1V & turn off all for 0V)
7. Dice Game Simulation Instead of using the conventional dice, generate a random value similar to dice value and display the
same using a 16X2 LCD. A possible extension could be to provide the user with option of selecting single or double dice game.
8. Displaying RSS News Feed On Display Interface Displaying the RSS news feed headlines on a LCD display connected to device. This can be adapted to other websites like twitter or other information websites. Python can be used to acquire data from the internet.
9. Porting Openwrt To the Device Attempt to use the device while connecting to a wifi network using a USB dongle and at the same time providing a wireless access point to the dongle.
10. Hosting a website on Board Building and hosting a simple website(static/dynamic) on the device and make it accessible online. There is a need to install server(eg: Apache) and thereby host the website.
11. Webcam Server Interfacing the regular usb webcam with the device and turn it into fully functional IP webcam & test the functionality.
12. FM Transmission Transforming the device into a regular fm transmitter capable of transmitting audio at desired frequency
(generally 88-108 Mhz)
Note: Devices mentioned in the above lists include Arduino, Raspbery Pi, Beaglebone

Subject: Project
Code: RBPR692
Contact Hours/week: 3L+1T
Credits: 3

Objectives: This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.