E.G.S. PILLAY ENGINEERING COLLEGE

(Autonomous)

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NAGAPATTINAM – 611002

M.E. MANUFACTURING ENGINEERING

REGULATION -2021

First Year – Second Semester

Course Category	Course Code	Course Name	L	T	P	C	Maximum Marks		
							CA	ES	Total
Theory Course									
PCC	2102MF201	Industrial Automation and Mechatronics	3	0	0	3	40	60	100
PCC	2102MF202	Robot Design and Programming	3	0	0	3	40	60	100
PCC	2102MF203	Materials Technology	3	0	0	3	40	60	100
PEC	2103MF012	Program Elective – III(Production and Operations Management)	3	0	0	3	40	60	100
PEC	2103MF013	Program Elective – IV(Processing of Polymers And Composites)	3	0	0	3	40	60	100
AC		Audit Course – II	2	0	0	0	100	00	100
Laboratory Course									
PCC	2102MF204	Industrial Automation and Mechatronics Laboratory	0	0	4	2	50	50	100
PCC	2102MF205	Modeling and Simulation Laboratory	0	0	4	2	50	50	100
EEC	2104MF206	Mini Project with Seminar	0	0	4	2	50	50	100
Total			**17**	**0**	**12**	**21**	**450**	**450**	**900**

PCC		INDUSTRIAL AUTOMATION AND MECHATRONICS	L	T	P	C
2102MF201			3	0	0	3

Course Objectives:

1. This syllabus is formed to create knowledge in Industrial Automation and Mechatronics systems and impart the source of concepts and techniques, which have recently been applied in practical situation
2. It gives the frame work of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering.

MODULE I	**INDUSTRIAL AUTOMATION**	**8 Hours**

Role of automation in industries, Benefits of automation –Introduction to fluid power, Advantages of fluid power, Application of fluid power system -Types of fluid power systems -Introduction to automation tools: Low cost automation, PLC, DCS, SCADA -Automation strategy evolution.

MODULE II	**INTRODUCTION TO MECHATRONICS**	**8 Hours**

Introduction to Mechatronics-systems – Mechatronics approach to modern engineering and design – Need of Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics – Mechatronics elements

MODULE III	**SENSORS AND TRANSDUCERS**	**12 Hours**

Introduction – Performance Terminology – Potentiometers – Strain gauges – LVDT – Eddy current sensor – Hall effect sensor – Capacitance sensors – Digital transducers – Temperature sensors – Optical sensors – Piezo electric sensor- ultrasonic sensors – Proximity sensors – Signal processing techniques.

MODULE IV	**ACTUATORS**	**8 Hours**

Switching Devices, Classification of actuators – Electrical actuators – Solid state relays, solenoids, D.C. motors, Servo motors, Stepper motors – Interfacing with microcontroller through H-bridge Circuits – Piezo electric actuators.

MODULE V	**MECHATRONIC SYSTEMS**	**9 Hours**

Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies – Engine management system, Automatic camera, Automatic washing machine, Pick and place robots.

Total:	**45 Hours**

Course Outcomes:

CO1 : Understand the concepts of industrial automation
CO2 : Discuss the components of Mechatronic systems.
CO3 :.Select the suitable sensors and transducers in an automation application
CO4 : Select the most appropriate actuators for an engineering application
CO5 : Explain mechatronic systems with case studies.

References:

1. R.K.Rajput. A Text Book of Mechatronics, Chand &Co,2
2. W.Bolton, Mechatronics, Pearson Education Limited,2004
3. M.A. Mazidi & J.G. Mazidi, 8051 Microcontroller and embedded systems,2002
4. Devadasshetty, Richard A. Kolk, ―Mechatronics System Design, PWS Publishing Company, 2001.

PCC		ROBOT DESIGN AND PROGRAMMING	L	T	P	C
2102MF202			3	0	0	3

Course Objectives:

- To gain knowledge on growth of robots since origin based on the application.
- To study the kinematics of robot.
- To study the dynamics of robot.
- To expose the students in the various programming techniques in robot and illuminate the curiosity over recent AI techniques.
- To familiarize the sensors and actuators involved in the robot based the application.

MODULE I	INTRODUCTION	9 Hours

Definition, Need Application, Types of robots – Classifications – Configuration, work volume, control loops, controls and intelligence, specifications of robot, degrees of freedoms, end effectors – types, selection applications.

MODULE II	ROBOT KINEMATICS	9 Hours

Introduction – Matrix representation Homogeneous transformation, forward and inverse – Kinematic equations, Denvit – Hartenbers representations – Inverse Kinematic relations. Fundamental problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Charges between frames:

MODULE III	ROBOT DYNAMICS AND TRAJECTORY PLANNING	9 Hours

Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning

MODULE IV	ROBOT PROGRAMMING AND AI TECHNIQUES	9 Hours

Types of Programming – Teach Pendant programming – Basic concepts in AI techniques – Conceptof knowledge representations – Expert system and its components.

MODULE V	ROBOT SENSORS AND ACTUATORS	9 Hours

Design of Robots – characteristics of actuating systems, comparison, microprocessors control of electric motors, magnetostrictive actuators, shape memory type metals, sensors, position, velocity, force, temperature, pressure sensors – Contact and non contact sensors, infrared sensors, RCC, vision sensors.

	Total:	45 Hours

Course Outcomes:

Students will able to

CO1 : Apply their knowledge on calculation of end effector coordinate position and angle based onthe application.

CO2 : Calculate force involved in the robot while under operation (i.e. gripping force).

CO3 : Compute the trajectory of robot based on both joint space and Cartesian space.

CO4 : Understand the traditional programming in robot and Modern AI Techniques.

CO5 : Identify appropriate sensors and actuators based on the application.

References:

1. Fu K S, Gonzalez, Lee C S G, Robotics: Control, Sensing, Vision and Intelligence, McGraw- Hill Book Company, 1987.
2. Gordon Mair, 'Industrial Robotics', Prentice Hall U.K, 1998.
3. Groover.M.P. Industrial Robotics, McGraw – Hill International edition, 2012.
4. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 3rd edition, 2004.
5. Saeed.B.Niku, 'Introduction to Robotics, Analysis, system, Applications', Pearson educations, 2010.
6. Wesley E Snyder R, 'Industrial Robots, Computer Interfacing and Control', Prentice Hall International Edition, 2013.

PCC		MATERIALS TECHNOLOGY	L	T	P	C
2102MF203			3	0	0	3

Course Objectives:

- To understand the elastic and plastic behaviour of materials.
- To impart knowledge on fracture analysis.
- To familiarize on modern metallic materials.
- To review on polymeric and ceramics materials and their applications.
- To enable student to select material for specific applications.

MODULE I	ELASTIC AND PLASTIC BEHAVIOR	9 Hours

Elasticity in metals and polymers Anelastic and visco-elastic behaviour – Mechanism of plastic deformation shear strength of perfect and real crystals – Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre, dispersion and texture strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity – Deformation of polymeric, ceramic and non-crystalline materials.

MODULE II	FRACTURE BEHAVIOUR	9 Hours

Griffith's theory, stress intensity factor, J-Integral and fracture toughness – Toughening mechanisms – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law. Effect of surface and metallurgical parameters on fatigue – Fracture in ceramics and polymers – Failure analysis, sources of failure, procedure of failure analysis.

MODULE III	MODERN METALLIC MATERIALS	9 Hours

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel, Super alloys –Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass nano crystalline materials and composite materials.

MODULE IV	NON METALLIC MATERIALS	9 Hours

Polymeric materials – Formation of polymer structure – Production techniques of fibres, foams, adhesives and coating – structure, properties and applications of Commodity and engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al_2O_3, SiC, Si_3N_4 CBN and diamond – properties, applications as abrasives and cutting tool- Properties and applications of CNT – Graphene based Material

MODULE V	SELECTION OF MATERIALS	9 Hours

Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for Atmospheric, water, Soil and chemical, corrosion Selection for adhesive and abrasive wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery, chemical and nuclear applications.

Total:	45 Hours

Course Outcomes:

Students will able to

CO1 : Get knowledge of mechanism of failure of materials and methods.

CO2 : Fully appreciate modification of material property to suit the specific requirements.

CO3 : Express and appreciate the existing materials and development of upcoming new materials.

CO4 : Have the knowledge to select the various non-metallic materials to suit required applications

CO5 : Identify and select suitable material for relevant application.

References:

1. Ashby M.F., Material Selection in Mechanical Design, 5thEdition, Butter Worth 2017.
2. ASM Hand book, Vol.11, Failure Analysis and Prevention, 10thEdition, ASM, 2002.
3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, 3rd edition, Butterworth-Heiremann, 2001.
4. Thomas H. Courtney, Mechanical Behaviour of Materials, 2ndedition, McGraw Hill, 2000.
5. Marc Andre, Meyers and Krishan Kumar Chawla, Mechanical Behaviour of Materials, 2ndEdition, Cambridge University Press, 2009.
6. George E.Dieter, Mechanical Metallurgy, 3rd Edition,McGraw Hill, 2014.

PEC			L	T	P	C
2103MF012		PRODUCTION AND OPERATIONS MANAGEMENT	3	0	0	3

Course Objectives:

- To familiarize with various forecasting models.
- To impress upon the importance of sequencing problem in industries.
- To design and develop inventory control models for a given industry.
- To familiarize with project management techniques such as CPM and PERT.
- To train on plant engineering techniques such as plant location, plant layout, materials handling and work study.

MODULE I	FORECASTING	9 Hours

Forecasts-Types-Purpose- opinion and judgmental method-Time series methods – moving average - weighted moving average – method of least squares – Exponential smoothing method- Regression and correlation methods – simple and multiple regression – Linear and Nonlinear regression.

MODULE II	SCHEDULING AND SEQUENCING	9 Hours

Scheduling – Single Criterion rules –Sequencing –n job 2 machine problem – Johnson's algorithm –3 machine problem – M machine problem – Graphical method for 2 jobs M machine problems – Heuristic methods.

MODULE III	INVENTORY	9 Hours

Inventory – purpose of inventory – Basic EOQ Model –Quantity discount model – Reorder level – Fixed order quantity inventory system – Periodic review system – ABC analysis – Materials requirement planning – EOQ models under constraints – Purchasing management – Stores management – Just In Time inventory system – Vendor evaluation - Inventory pricing – Supply chain Management – Aggregate planning.

MODULE IV	PROJECT MANAGEMENT	9 Hours

Project network analysis – Activities – Events- critical path method – Method based on time estimates– Programme Evaluation Review Technique –Optimistic, pessimistic time, most likely time - Probability of completion of projects – Time crashing of Projects –Optimum duration and cost.

MODULE V	PLANT ENGINEERING AND WORK STUDY	9 Hours

Plant location – Factors affecting plant location – Break even analysis- Factors weighted ratingmethod – Plant layout-Types- Selection – Plant layout Techniques – Travel chart method – Line balancing method– Work study – method study – Principles of Motion economy – steps in methods study - Charts – Micromotion study-memo motion study – multiple activity charts- therbligs – work measurement – stop watch time study – Production studies – PMTS – Work sampling – Materials handling – Principles – Selection.

Total:	45 Hours

Course Outcomes:

Students will be able to

CO1 : Select an appropriate forecasting method for a given industry

CO2 : Obtain optimal solutions for sequencing problem in industry.

CO3 : Design a suitable inventory system for any particular industry.

CO4 : Use the project management techniques to minimize the project time.

CO5 : Design plant layout and materials handling systems and can make use of the concepts of workstudy for work design.

References:

1. Chary S.N Production and Operations Management, Tata McGraw Hill, 3rd Edition 2012.
2. Kanishka Bedi, Production and Operations Management, Oxford University Press,3rdEdition 2016.
3. Norma Gaither and Gregory Frazier, Operations Management, Cengage Learning, 9thEdition,2016.
4. Pannerselvam R, Production and Operations Management, Prentice Hall of India, 2ndEdition, 2008.
5. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, McGraw Hill,14th edition, 2017.
6. William J Stevenson, Operations Management, McGraw Hill, 11th edition, 2012.

PEC		PROCESSING OF POLYMERS AND COMPOSITES	L	T	P	C
2103MF013			3	0	0	3

Course Objectives:

- To introduce the various processing methods of polymers.
- To enlighten the students about the different types of fibres and matrix materials.
- To analyse the different polymer matrix composites processing methods and their applications.
- To expose the students to the various metal matrix composite processing methods.
- To analyse the various processing techniques of various ceramic matrix composites.

MODULE I **PROCESSING OF POLYMERS** **9 Hours**

Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics - Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming. General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Thermal bonding – Applications.

MODULE II **FIBRES AND MATRIX MATERIALS** **9 Hours**

Fibres – Fabrication, Structure, properties and applications – Glass fibre, Boron fibre, carbon fibre, organic fibre, ceramic and metallic fibres - whiskers–Fabrication of Matrix materials – polymers, metals and ceramics and their properties – interfaces – Wettability – Types of bonding at the interface – Tests for measuring interfacial strength - Physical and chemical properties.

MODULE III **PROCESSING OF POLYMER MATRIX COMPOSITES** **9 Hours**

Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound – thermoplastic matrix composites– film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – interfaces in PMCs-structure, properties and application of PMCs –recycling of PMCs.

MODULE IV **PROCESSING OF METAL MATRIX COMPOSITES** **9 Hours**

Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder metallurgy techniques- interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

MODULE V **PROCESSING OF CERAMIC MATRIX COMPOSITES AND CARBON-CARBON COMPOSITES** **9 Hours**

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – insitu chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, sol-gel-interfaces in CMCs – mechanical properties and applications of CMCs – Carbon-carbon Composites-applications.

Total: 45 Hours

Course Outcomes:

Students will be able to

CO1 : Get knowledge on various processing methods of polymers.

CO2 : Get knowledge about various types of fibres and matrix materials.

CO3 : Understand the various polymer matrix composites processing methods.

CO4 : Analyse the various processing methods of metal matrix composites.

CO5 : Analyse the various processing techniques of ceramic matrix composites.

References:

1. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers, 2002.
2. Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009.
3. Krishan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012.
4. Mallick P.K. and Newman S, Composite Materials Technology, Hanser Publishers, 2003.
5. Mallick P.K., Fibre Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010.
6. Seamour E.B, Modern Plastics Technology, Prentice Hall, 2002

PCC		INDUSTRIAL AUTOMATION AND MECHATRONICS LABORATORY	L	T	P	C
2102MF204			0	0	4	2

Course Objectives:	
	To train the students to have a hands on training of the basic concepts of various industrial automation and Mechatronics systems

Experiments:

1. Simulation of single and double acting cylinder circuits
2. Simulation of Hydraulic circuits
3. Simulation of electro pneumatic circuits
4. Simulation of electro hydraulic circuits
5. Simulation of PLC circuits
6. Software simulation of fluid power circuits using a software package.
7. Simulation of various Mechatronics systems using hardware components

	Total:	**60 Hours**

Course Outcomes:	
	Students will be able to
	CO1 : Create the pneumatic and hydraulic circuits using autoSIM software.
	CO2 : Prepare PLC ladder programming for industrial applications.
	CO3 : Design a mechatronics system according to an industrial applications.

PCC		MODELLING AND SIMULATION LABORATORY	L	T	P	C
2102MF205			0	0	4	2

Course Objectives:

- To study the fundamentals of finite element analysis from classical method to nodal approximation method in various fields of manufacturing applications.
- To make the students to design an element by Finite element analysis.
- To develop the knowledge related to modelling and simulation in field of manufacturing.

LIST OF EXERCISES

1. One Dimensional FEA Problem like beam, Truss etc.
2. Two Dimensional FEA Problems like plane stress, plane strain, axisymmetric and vibration.
3. Three Dimensional FEA Problems like shell and contact.
4. FEA Application in metal forming like superplastic forming, deep drawing etc
5. FEA Application in Metal cutting
6. FEA Application in Casting process
7. 3D Modelling and Assemble of Engine
8. Modelling of Crack Shaft
9. Modelling of Connecting Rod
10. Modelling of Cotter Joint
11. Modelling of Plummer Block and Coupling

(Any 10 for Conduct of end semester examination)

	Total:	**60 Hours**

Course Outcomes:

Students will be able to

CO1 : Apply the principles of Finite Element Analysis to solve problems in the field of production engineering.

CO2 : design and analyse various problems in field of manufacturing

CO3 : identify the problems and simulate using Finite element analysis

CO4 : Relate to Finite element analysis in various manufacturing applications.

CO5 : Develop skills in field of design and simulation using FEA.

PCC		MINI PROJECT WITH SEMINAR	L	T	P	C
2104MF206			0	0	2	1

Objectives:	
	• To prepare students to identify a problem for study.
	• To do literature review of a problem.
	• To enable to comprehend information in form of presentation both written and oral, to develop technical communication skills.
	• To carry out modelling/ conduct experiments beyond regular laboratory exercises in developing solution to the identified problem.
	• To cultivate spirit of team work in working as a group.
	A student has to choose a problem and carry out scientific systematic investigation experimentally/ theoretically in suggesting a viable solution. At the end of the semester, each group of students have to submit a report for evaluation.
	TOTAL: 30 PERIODS
OUTCOMES	
Students at the end of course will be	
	• To critically observe the world around and identify a problem that can be solved.
	• To develop skills of read and comprehensively analysing the facts.
	• To exhibit skill of presentation both orally and in written form.
	• To get hands on experience to doing experimental/ theoretical analysis in synthesis ofsolution to the problem
	• Able to appreciate the importance of team work