RAJALAKSHMI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University, Chennai)

Common Open Electives for PG courses as per R2019

List of Open Electives

SNo.	Dept	Subject Code	Subject Name (Theory course)	Category	L	T	P	C
1	IT	CP19O31	Business Analytics	OE	3	0	0	3
2	BioTech	PG19O33	Waste to Energy	OE	2	1	0	3
3	Mech	ED19O33	Composite Materials	OE	3	0	0	3
4	Mech	ED19O31	Industrial Safety	OE	3	0	0	3
5	Mech	ED19032	Operations Research	OE	3	0	0	3

Department of Information Technology

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19O31	**BUSINESS ANALYTICS**	**OE**	**3**	**0**	**0**	**3**

Objectives:	
●	To understand the role of business analytics within an organization.
●	To analyze data using statistical and data mining techniques.
●	To gain an understanding of how managers use business analytics to formulate and solve business problems.
●	To become familiar with processes needed to develop, report, and analyze business data.
●	To use decision-making tools/Operations research techniques.

UNIT-I	**INTRODUCTION**	**9**
Business analytics: Overview of Business analytics– Scope of Business analytics– Business Analytics Process– Relationship of Business Analytics Process and organization – competitive advantages of Business Analytics– Statistical Tools: Statistical Notation– Descriptive Statistical methods– Review of probability distribution and data modelling– sampling and estimation methods overview.		
UNIT-II	**REGRESSION AND VISUALIZATION**	**9**
-Trendiness and Regression Analysis: Modelling Relationships and Trends in Data– simple Linear Regression. –Important Resources– Business Analytics Personnel– Data and models for Business analytics– problem solving– Visualizing and Exploring Data–Business Analytics Technology		
UNIT-III	**ANALYTICAL MODELS**	**9**
Organization Structures of Business analytics–Team management–Management Issues– Designing Information Policy– Outsourcing– Ensuring Data Quality– Measuring contribution of Business analytics– Managing Changes. Descriptive Analytics– predictive analytics– predicative Modelling– Predictive analytics analysis– Data Mining and Methodologies– Prescriptive analytics and its step in the business analytics Process– Prescriptive Modelling–nonlinear Optimization.		
UNIT-IV	**FORECASTING TECHNIQUES**	**9**
Qualitative and Judgmental Forecasting– Statistical Forecasting Models– Forecasting Models for Stationary Time Series– Forecasting Models for Time Series with a Linear Trend– Forecasting Time Series with Seasonality– Regression Forecasting with Casual Variables– Selecting Appropriate Forecasting Models– Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform– New-Product Development Model,–Newsvendor Model– Overbooking Model– Cash Budget Model.		
UNIT-V	**DECISION ANALYSIS**	**9**
Decision Analysis: Formulating Decision Problems– Decision Strategies with the without Outcome Probabilities– Decision Trees– The Value of Information, Utility and Decision Making– Recent Trends in: Embedded and collaborative business intelligence– Visual data recovery– Data Storytelling and Data journalism.		

	Total Contact Hours	**:**	**45**

Course Outcomes: Upon completion of the course, the students will be able to	
●	Demonstrate knowledge of data analytics.
●	Think critically in making decisions based on data and deep analytics.
●	Use technical skills in predicative and prescriptive modeling.
●	Translate data into clear, actionable insights.
●	Make decisions using various tools.

Reference Book(s):	
1	Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications", Pearson FT Press, 2014.
2	James R Evans, "Business Analytics", Pearson's Education, 2016.

CO - PO matrices of course

PO / CO	PO1	PO2	PO3	PO4	PO5
CP19O31.1	1	-	3	3	2
CP19O31.2	3	3	3	3	2
CP19O31.3	3	1	3	3	2
CP19O31.4	3	2	3	3	1
CP19O31.5	3	3	3	3	3
AVERAGE	2.6	2.3	3.0	3.0	2.0

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Department of Bio-Technology

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
PG19O33	Waste to Energy	OE	2	1	0	3

Course Objectives:

- To provide knowledge on solid waste sources.
- To identify the methods of solid waste disposal.
- To impart knowledge on energy generation by Bio-Chemical Conversion.
- To provide knowledge on energy generation by Thermo- Chemical Conversion.
- To impart knowledge on e-waste

UNIT-I **Solid Waste Sources** **9**

Solid Waste Sources, types, composition, Properties, Global warming, Municipal Solid Waste: Physical, chemical and biological properties , Waste Collection and, Transfer stations, Waste minimization and recycling of municipal waste, Segregation of waste, Size Reduction , Managing Waste. Status of technologies for generation of Energy from Waste Treatment and Disposal Aerobic composting, incineration, Furnace type and design, Medical waste /Pharmaceutical waste treatment Technologies, incineration, Environmental impacts, Measures to mitigate environmental effects due to incineration .

UNIT-II **Solid Waste Disposal Methods** **9**

Land fill classification, Types, methods and Sitting consideration, Layout and preliminary design of landfills: Composition, characteristics, generation, Movement and control of landfill leach ate and gases, Environmental monitoring system for land fill gases.

UNIT-III **Energy Generation from Waste Bio-chemical Conversion** **9**

Sources of energy generation, anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, Industrial waste, agro residues, Anaerobic Digestion.

UNIT-IV **Energy Generation from Thermo-chemical Conversion** **9**

Biogas production, Land fill gas generation and utilization, Thermo-chemical conversion: Sources of energy generation, Gasification of waste using Gasifiers, Briquetting, Utilization and advantages of briquetting, Environmental benefits of Bio-chemical and Thermo- chemical conversion.

UNIT-V **E-waste** **9**

E-waste in the global context – Growth of Electrical and Electronics Industry in India – Environmental concerns and health hazards – Recycling e-waste: a thriving economy of the unorganized sector – Global trade in hazardous waste – impact of hazardous e-waste in India. Management of e-waste: e-waste legislation, Government regulations on e-waste management – International experience – need for stringent health safeguards and environmental protection laws of India.

Total Contact Hours : 45

Course Outcomes: Upon the completion of the subject, the student will be able to

- Understand the technologies for generation of energy from solid waste
- Compare the methods of solid waste disposal
- Understand the concept of energy generation by Bio-chemical conversion
- Understand the concept of energy generation by Thermo-chemical conversion
- Understand about e-waste

Text Book (s):

1. P. Aarne Vesilind, William A. Worrell and Debra R. Reinhart. “Solid Waste Engineering”, Second edition, Cengage learning India Pvt. Limited, 2016
2. Nicholas P. Cheremisinoff, “ Handbook of Solid Waste Management and Waste Minimization Technologies”, An Imprint of Elsevier, New Delhi, 2003
3. Zander Ellis, “Industrial Waste Management”, Larsen and Keller Education, 2017

Reference Books(s) / Web links:

1. C Parker and T Roberts (Ed), “Energy from Waste – An Evaluation of Conversion Technologies”, Elsevier Applied Science, London, 1985
2. Sofer, Samir S, Oskar R. Zaborsky, “Biomass Conversion Processes for Energy and Fuels”, Springer, 2012
3. Hagerty, D.Joseph; Pavoni, Joseph L; Heer, John E., “Solid Waste Management”, New York, Van Nostrand, 1973

4	Amalendu Bagchi. "Design of Landfills and Integrated Solid Waste Management". 3rd edition, John Wiley and Sons. New York, 2004
5	C. S. Rao. "Environmental Pollution Control Engineering", Wiley Eastern Ltd. New Delhi (1995)
6	"E-waste in India: Research unit, Rajya Sabha Secretariat, New Delhi, June 2011"
7	KL Shah, "Basics of Solid and Hazardous Waste Management Technology", Prentice Hall, 2003
8	M Datta, "Waste Disposal in Engineered Landfills", Narosa Publishing House, 1997

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1				
CO2	1	1				
CO3	1	1				
CO4	1	1				
CO5	1	1				
AVG	**1**	**1**	**0**	**0**	**0**	**0**

Department of Mechanical Engineering

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ED19O33	**COMPOSITE MATERIALS**	OE	3	0	0	3

Objectives:	
	To understand the fundamentals of composite material, its applications and various fiber production techniques.
	To have the knowledge of the Polymer matrix composites, its manufacturing and its applications.
	To have the knowledge of the Metal matrix composites, its manufacturing and its applications.
	To have the knowledge of the Ceramic matrix composites, its manufacturing and its applications.
	To study the geometrical aspects of composite materials and its mechanical properties fatigue and creep.

UNIT-I	**Introduction to composites**	9
Fundamentals of composites – need for composites – enhancement of properties – classification of composites –Fabrication of Matrix materials – properties - Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – particle, whisker and fibre reinforced composites. Applications of various types of composites. Fiber production techniques for Glass fibre, Aramid fibre, Carbon fibre, Boron fibre - Wettability- Effect of surface roughness- Interfacial bonding – Methods measuring bond strength.		

UNIT-II	**Polymer matrix composites**	9
Types – Processing – Thermo sensing matrix composites – Hand layup and sprayup techniques, filament winding, pultrusion, resin transfer moulding, autoclave moulding – thermoplastic matrix composites – Injection moulding, film stacking – diaphragm forming – thermoplastic tape laying. Fibre reinforced		

plastics (FRP), Glass Fibre Reinforced Plastics (GFRP). Mechanical properties -applications of PMC in aerospace, automotive industries

UNIT-III	**Metal matrix composites**	9
Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries		

UNIT-IV	**Ceramic matrix composites**	9
Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics – need for CMC – ceramic matrix – various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering – Hot pressing – Cold isostatic pressing – Hot isostatic pressing. applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique-Processing of Ceramic Matrix composites.		

UNIT-V	**Geometrical aspects, Fatigue and Creep in composite materials**	9
Unidirectional laminas – Volume fraction and weight fraction woven roving, inplane range fibres – fibre length and fibre orientation distribution – voids – fibre Orientation during flow. Fatigue S.N curves – fatigue behaviors of CMCs – fatigue – particle and whisker reinforced composites – Hybrid composites – thermal fatigue – creep.		

Course Outcomes: At the end of this course, the student can	
□	Understand the fundamentals of composites and fiber production techniques
□	Know the types and various manufacturing methods of PMC
□	Know the types and various manufacturing methods of MMC
□	Know the types and various manufacturing methods of CMC
□	Understand the geometrical aspects of composite materials.

Text Book:

1. Krishnan K. Chawla, “composite Materials Science and Engineering”, Springer, 2013.
2. Mathews F.L. and Rawlings R.D, “composite Materials: Engineering and Science”, CRC Press and wood head Publish Limited, 2014.2 Maintenance Engineering, H. P. Garg, S. Chand and Company.

Reference:

1.Derek Hull, “An Introduction to composite Materials”, Cambridge University Press, 2019.
2.Strong, A.B., “Fundamentals of Composite Manufacturing”, SME, 2008.
3.Sharma, S.C., “Composite materials”, Narosa Publications, 2004.
4.Broutman, L.J. and Krock, R.M., “ Modern Composite Materials”, Addison-Wesley, 1967.
5.ASM Hand Book, “Composites”, Vol.21, ASM International, 2017.

PEO’S MAPPING with Course Outcome:

PEO / CO	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2	3	-
CO2	2	2	3	-
CO3	2	2	3	-
CO4	2	2	3	-
CO5	2	2	3	-
Average	2	2	3	-

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ED19O31	**INDUSTRIAL SAFETY**	OE	3	0	0	3

Objectives:	
	To understand the Fundamental concept and Principle of Industrial Safety
	To apply the principle of Maintenance Engineering
	To Study about various types of wear and methods to reduce it.
	To know about various fault finding methods of machine tools
	To understand about preventive and periodic maintenance methods.

UNIT-I	**Industrial Safety**	12
Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety colour codes. Fire prevention and firefighting, equipment and methods.		

UNIT-II	**Fundamentals of maintenance engineering**	10
Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.		

UNIT-III	Wear and Corrosion and their prevention	10
Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods		

UNIT-IV	Fault tracing	14
Fault tracing-concept and importance, decision tree concept, need and. applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.		

UNIT-V	Periodic and preventive maintenance	14
Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance		

Course Outcomes: At the end of this course, the student can	
□	Explain the fundamental concept and principles of industrial safety
□	Apply the principle of Maintenance engineering
□	Able to understand the types of wear and methods to reduce it.
□	Able to find various faults in machine tools
□	Able to apply periodic maintenance for various equipment's.

Reference:

1. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.
2 Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.

4. R. Keith Mobley, Maintenance Fundamentals, Elsevier, 2011.
5 .Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
6. Pump-hydraulic Compressors, Audels, McGraw Hill Publication.

PEO'S MAPPING with Course Outcome:

PEO / CO	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2	2	-
CO2	2	2	2	-
CO3	2	2	2	-
CO4	3	2	2	-
CO5	3	2	2	-
Average	2.4	2	2	-

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
ED19032	**OPERATIONS RESEARCH**	**OE**	**3**	**0**	**0**	**3**

Objectives:	
□	To create awareness about optimization techniques in utilization of resources and to formulate the linear programming model for industrial applications based on the constraints and availability of the resources .
□	To provide knowledge and training in Transportation and other production models and to obtain the optimal solution to maximize the profit .
□	To provide knowledge about the Network models and to furnish the solution for the failure of item
□	To understand the deterministic and stochastic inventory models and to plan , manage the stocks to meet the customer demands
□	To understand the Queuing models , queue discipline and to explore the ways to give better customer service

UNIT-I	LINEAR PROGRAMMING MODELS	9
Introduction to Operations Research - Scope , objectives , phases , models and limitations . Linear programming – formulation of LPP - Graphical method – Simplex algorithm – Artificial variables – Big M method – Two phase method – Duality formulation.		

UNIT-II	TRANSPORTATION MODELS	9
Transportation models - Finding basic feasible solution – LCM , NWC and VAM methods – Optimal solution using MODI method – Unbalanced model and Degeneracy **Assignment Models** – Hungarian method for optimal solution - Unbalanced problem - Traveling Salesman problem **Sequencing models** - Processing n Jobs through 2 Machines , n Jobs through 3 Machines , n Jobs through m Machines using Johnson algorithm		

UNIT-III	NETWORK AND REPLACEMENT MODELS	9
Networks models : Network logic – Ford-Fulkerson's rule – Shortest route – Project network – CPM and PERT networks – Critical path scheduling – Types of Floats and calculations Replacement models : Types of failures - present value factor - Replacement of Items that deteriorate with time, Items that fail suddenly - Individual and Group replacement policies.		

UNIT-IV	INVENTORY MODELS	9
Need for Inventory – Types of Inventory – Inventory costs - Economic order quantity – Deterministic Inventory models – with and without shortages - Quantity discount models – Stochastic inventory models – Multi product models – Inventory control – P and Q systems - Determination of Buffer stock and Reorder level .		

UNIT-V	QUEUEING MODELS	9
Queueing models - Queueing systems and structures – Notation parameter – Poisson input – Exponential service - Single server and multi server models — Constant rate service – Infinite population – Simulation – Monte Carlo technique – Inventory and Queuing problems .		

Course Outcomes: At the end of this course, the student can	
□	Formulate a real-world problem as a mathematical linear programming model , select the constraints based on the availability of the resources and determine the optimal solution.
□	Build and solve specialized Transportation, Assignment and Sequencing problems with optimum results
□	Investigate the nature of the project/ failure and give suggestions towards decision making.
□	Know about the maintenance of inventory level , Plan the manufacturing policies, manage the stocks according to the customer demands..
□	Model a dynamic system as a queuing model and compute important performance measures for better customer service

Reference:

1	HamdyATaha, “Operations research an introduction”, 10th edition, PHI/Pearson education, 2017.
2	Wayne L. Winston, Jeffrey B. Goldberg “Operations research applications and algorithms”, Thomson Brooks/Cole, 2004
3	Premkumar Gupta and D.S.Hira, “Problems in Operations research”, S.Chand, 2009
4	Sharma J K, “Operations research theory and applications”,5th edition, Macmillan India, 2013.
5.	Pannerselvam R, “Operations research”, 2nd edition, PHI, 2009.
6.	Srinivasan G, “Operations research principles and applications”, 3rd edition EEE PHI, 2017.

7.	Tulsian and Pasdey V., “Quantitative Techniques”, Pearson Asia, 2002.

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO5**	**PO6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	2	2	1	1	-	1	1	2	3	-	-	3
CO 2	3	3	2	2	2	1	1	-	1	1	2	3	-	-	3
CO 3	3	3	2	2	2	1	1	-	1	1	2	3	-	-	3
CO 4	3	3	2	2	2	1	1	-	1	1	2	3	-	-	3
CO 5	3	3	2	2	2	1	1	-	1	1	2	3	-	-	3