DEPARTMENT OF MECHANICAL ENGINEERING

M.E – INDUSTRIAL SAFETY ENGINEERING

CURRICULUM & SYLLABI

Regulation 2020

(Applicable to candidates admitted in the academic year 2020 - 2021 onwards)

K.S.R. College of Engineering (Autonomous)

(Approved by AICTE, Accredited by NAAC with A++ grade & Affiliated to Anna University)
K.S.R. Kalvi Nagar, Tiruchengode – 637 215

Namakkal (Dt), Tamilnadu, India

Email : info@ksrce.ac.in **Website :** www.ksrce.ac.in

K.S.R. COLLEGE OF ENGINEERING : TIRUCHENGODE - 637 215
(Autonomous)
DEPARTMENT OF INDUSTRIAL SAFETY ENGINEERING

(REGULATION 2020)

Vision of the Institution

IV	We envision to achieve status as an excellent educational institution in the global knowledge hub, making self-learners, experts, ethical and responsible engineers, technologists, scientists, managers, administrators and entrepreneurs who will significantly contribute to research and environment friendly sustainable growth of the nation and the world.

Mission of the Institution

IM 1	To inculcate in the students self-learning abilities that enable them to become competitive and considerate engineers, technologists, scientists, managers, administrators and entrepreneurs by diligently imparting the best of education, nurturing environmental and social needs.
IM 2	To foster and maintain mutually beneficial partnership with global industries and Institutions through knowledge sharing, collaborative research and innovation.

Vision of the Department / Programme: (Industrial Safety Engineering)

DV	To be a centre of excellence in the field of Mechanical Engineering for providing its students and faculty with opportunities for excel in education and targeted research themes in emerging areas.

Mission of the Department / Programme: (Industrial Safety Engineering)

DM 1	To excel in academic and research activities that meet the industrial and social needs.
DM 2	To develop competent, innovative and ethical mechanical Engineers.

Programme Educational Objectives (PEOs) :(Industrial Safety Engineering)

The graduates of the programme will be able to

PEO 1	Enhance the skills and knowledge on safety, health and environment with respect to industry and research, for executing safe methods in complex engineering problems.
PEO 2	Understand the impact of safety, health and environmental solutions on productivity, quality and societal at large.
PEO 3	To comply with legal safety, ethical and contractual requirements, professional practices to contribute the community for the sustainable development of society.

K.S.R. COLLEGE OF ENGINEERING : TIRUCHENGODE - 637 215
(Autonomous)
DEPARTMENT OF INDUSTRIAL SAFETY ENGINEERING

(REGULATION 2020)

PROGRAMME OUTCOMES (POs) AND PROGRAMME SPECIFIC OUTCOMES (PSOs)

Programme Outcomes (POs)	
PO1	An ability to independently carry out research / investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report / document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be a level higher than the requirements in the appropriate bachelor program.
PO4	An ability to attain, identify and apply knowledge of mathematics, soft computing & soft skill and management for various academic and industrial needs.
Programme Specific Outcomes (PSOs)	
PSO1	Students should be able to use techniques and modern engineering tools for engineering practices in their immediate employment and/or entrepreneurial activities.
PSO2	Contribute to the core universal human values and social good to community with respect to industrial safety, health and environment/

KSR College of Engineering	**K.S.R. COLLEGE OF ENGINEERING (Autonomous)** (Approved by AICTE, Affiliated to Anna University & Accredited by NAAC with "A++" Grade) **K.S.R. Kalvi Nagar, Tiruchengode - 637 215**	**CURRICULUM** **PG** **R - 2020**

Department	Department of Mechanical Engineering
Programme	M.E. - Industrial Safety Engineering

SEMESTER - I

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	IS20111	Principles of Safety Management	3	0	0	3	30	70	100
2.	IS20112	Environmental Safety	3	0	0	3	30	70	100
3.	IS20113	Occupational Health and Industrial Hygiene	3	0	0	3	30	70	100
4.	MA20135	Applied Statistics	3	0	0	3	30	70	100
5.	IS20115	Industrial Safety, Health and Environment (SHE) Acts	3	0	0	3	30	70	100
6.	IS20116	Human Factors Engineering	3	0	0	3	30	70	100
PRACTICAL									
7.	IS20121	Technical Presentation - I	0	2	0	1	50	50	100
		Total	**18**	**2**	**0**	**19**		**700**	

SEMESTER - II

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	IS20211	Fire Engineering and Explosion Control	3	0	0	3	30	70	100
2.	IS20212	Computer Aided Hazard Analysis	3	0	0	3	30	70	100
3.	IS20213	Electrical Safety	3	0	0	3	30	70	100
4.	IS20214	Reliability Engineering	3	0	0	3	30	70	100
5.	IS20215	Safety in Chemical Industries	3	0	0	3	30	70	100
6.	IS20216	Safety in Engineering Industry	3	0	0	3	30	70	100
PRACTICAL									
7.	IS20221	Industrial Safety Laboratory	0	0	3	2	50	50	100
8.	IS20222	Technical Presentation - II	0	2	0	1	50	50	100
		Total	**18**	**2**	**3**	**21**		**800**	

KSR College of Engineering	**K.S.R. COLLEGE OF ENGINEERING (Autonomous)** (Approved by AICTE, Affiliated to Anna University & Accredited by NAAC with "A++" Grade) **K.S.R. Kalvi Nagar, Tiruchengode - 637 215**	**CURRICULUM** **PG** **R - 2020**

Department	Department of Mechanical Engineering
Programme	M.E. - Industrial Safety Engineering

SEMESTER - III

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	*******	Elective - I	3	0	0	3	30	70	100
2.	*******	Elective - II	3	0	0	3	30	70	100
3.	*******	Elective - III	3	0	0	3	30	70	100
4.	*******	Audit course	2	0	0	0	30	70	100
PRACTICAL									
5.	IS20321	Project Phase - I	0	0	12	6	50	50	100
		Total	**11**	**0**	**12**	**15**	**500**		

SEMESTER - IV

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
PRACTICAL									
1.	IS20421	Project Phase - II	0	0	24	12	50	50	100
		Total	**0**	**0**	**24**	**12**	**100**		

KSR College of Engineering	**K.S.R. COLLEGE OF ENGINEERING (Autonomous)** (Approved by AICTE, Affiliated to Anna University & Accredited by NAAC with "A++" Grade) **K.S.R. Kalvi Nagar, Tiruchengode - 637 215**	**CURRICULUM** **PG** **R - 2020**

Department	Department of Mechanical Engineering
Programme	M.E. - Industrial Safety Engineering

List of Electives

ELECTIVES (SEMESTER - III)

Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
1.	IS20361	Quality Engineering	3	0	0	3	30	70	100
2.	IS20362	Artificial Intelligence and Expert systems	3	0	0	3	30	70	100
3.	IS20363	Work Study and Ergonomics	3	0	0	3	30	70	100
4.	IS20364	Dock Safety	3	0	0	3	30	70	100
5.	IS20365	Safety in Construction	3	0	0	3	30	70	100
6.	IS20366	Transport Safety	3	0	0	3	30	70	100
7.	IS20367	Fireworks safety	3	0	0	3	30	70	100
8.	IS20368	Safety in Powder Handling	3	0	0	3	30	70	100
9.	IS20369	Nuclear Engineering and Safety	3	0	0	3	30	70	100
10.	IS20371	Safety in Textile Industry	3	0	0	3	30	70	100
11.	IS20372	Safety in Mines	3	0	0	3	30	70	100
12.	IS20373	Plant Layout and Materials Handling	3	0	0	3	30	70	100
13.	IS20374	Disaster Management	3	0	0	3	30	70	100
14.	IS20375	OHSAS18000 and ISO14000	3	0	0	3	30	70	100
15.	IS20376	Low Temperature Combustion	3	0	0	3	30	70	100
16.	IS20377	Bio Fuels in IC Engines	3	0	0	3	30	70	100
17.	IS20378	Refrigeration and Cryogenic Engineering	3	0	0	3	30	70	100
18.	IS20379	Energy Conservation and Management	3	0	0	3	30	70	100
19.	IS20380	Refrigeration and Air Conditioning	3	0	0	3	30	70	100
20.	IS20381	Food Processing, Preservation and Transport	3	0	0	3	30	70	100

AUDIT COURSE (SEMESTER - III)

Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
1.	IS20AU1	English For Research Paper Writing	2	0	0	0	30	70	100

DEPARTMENT OF MECHANICAL ENGINEERING

M.E – INDUSTRIAL SAFETY ENGINEERING

CURRICULUM & SYLLABI

Regulation 2020 (Amendment - 1)

(Applicable to candidates admitted in the academic year 2022 – 2023 (Odd Semester) onwards)

Ref. : BOS Meeting No :08 Dated 11-11-2022

K.S.R. College of Engineering (Autonomous)

(Approved by AICTE, Accredited by NAAC with A++ grade & Affiliated to Anna University)
K.S.R. Kalvi Nagar, Tiruchengode – 637 215

Namakkal (Dt), Tamilnadu, India

Email : info@ksrce.ac.in **Website :** www.ksrce.ac.in

K.S.R. COLLEGE OF ENGINEERING : TIRUCHENGODE - 637 215
(Autonomous)
DEPARTMENT OF INDUSTRIAL SAFETY ENGINEERING

(REGULATION 2020)

Vision of the Institution

IV	We envision to achieve status as an excellent educational institution in the global knowledge hub, making self-learners, experts, ethical and responsible engineers, technologists, scientists, managers, administrators and entrepreneurs who will significantly contribute to research and environment friendly sustainable growth of the nation and the world.

Mission of the Institution

IM 1	To inculcate in the students self-learning abilities that enable them to become competitive and considerate engineers, technologists, scientists, managers, administrators and entrepreneurs by diligently imparting the best of education, nurturing environmental and social needs.
IM 2	To foster and maintain mutually beneficial partnership with global industries and Institutions through knowledge sharing, collaborative research and innovation.

Vision of the Department / Programme: (Industrial Safety Engineering)

DV	To be a centre of excellence in the field of Mechanical Engineering for providing its students and faculty with opportunities for excel in education and targeted research themes in emerging areas.

Mission of the Department / Programme: (Industrial Safety Engineering)

DM 1	To excel in academic and research activities that meet the industrial and social needs.
DM 2	To develop competent, innovative and ethical mechanical Engineers.

Programme Educational Objectives (PEOs) :(Industrial Safety Engineering)

The graduates of the programme will be able to

PEO 1	Enhance the skills and knowledge on safety, health and environment with respect to industry and research, for executing safe methods in complex engineering problems.
PEO 2	Understand the impact of safety, health and environmental solutions on productivity, quality and societal at large.
PEO 3	To comply with legal safety, ethical and contractual requirements, professional practices to contribute the community for the sustainable development of society.

K.S.R. COLLEGE OF ENGINEERING : TIRUCHENGODE - 637 215
(Autonomous)
DEPARTMENT OF INDUSTRIAL SAFETY ENGINEERING

(REGULATION 2020)

PROGRAMME OUTCOMES (POs) AND PROGRAMME SPECIFIC OUTCOMES (PSOs)

Programme Outcomes (POs)	
PO1	An ability to independently carry out research / investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report / document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be a level higher than the requirements in the appropriate bachelor program.
PO4	An ability to attain, identify and apply knowledge of mathematics, soft computing & soft skill and management for various academic and industrial needs.
Programme Specific Outcomes (PSOs)	
PSO1	Students should be able to use techniques and modern engineering tools for engineering practices in their immediate employment and/or entrepreneurial activities.
PSO2	Contribute to the core universal human values and social good to community with respect to industrial safety, health and environment/

K.S.R COLLEGE OF ENGINEERING ,TIRUCHENGODE -637215

DEPARTMENT OF MECHANICAL ENGINEERING

M.E-(INDUSTRIAL SAFETY ENGINEERING)

(REGULATION- 2020) (Amendment-1)

The following courses have introduced in the third semester of M.E (Industrial safety Engineering) curriculum R2020 (Electives) for the purpose of emerging areas in the field of welding and advanced materials.

S.No	Course code	Course Name	Core / Elective	Semester	Applicable to candidates admitted in the academic year
1.	IS20382	Research Methodology and IPR	Elective	III	Academic Year 2022-2023
2.	IS20383	Advanced Materials	Elective	III	
3.	IS20384	Welding Economics, Management and Safety	Elective	III	
4.	IS20385	Composite Materials and Mechanics	Elective	III	
5.	IS20386	Additive Manufacturing	Elective	III	
6.	IS20387	Advanced Metrology and Non Destructive Testing	Elective	III	
7.	IS20388	Optimization Techniques In Manufacturing	Elective	III	
8.	IS20389	Plastics and Composite Materials	Elective	III	
9.	IS20391	Materials Testing and Characterization Techniques	Elective	III	
10.	IS20392	Non Destructive Testing and Evaluation	Elective	III	

KSR College of Engineering	**K.S.R. COLLEGE OF ENGINEERING (Autonomous)** (Approved by AICTE, Affiliated to Anna University & Accredited by NAAC with "A++" Grade) **K.S.R. Kalvi Nagar, Tiruchengode - 637 215**	**CURRICULUM** **PG** **R - 2020**

Department	Department of Mechanical Engineering
Programme	M.E. - Industrial Safety Engineering

SEMESTER - I

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	IS20111	Principles of Safety Management	3	0	0	3	40	60	100
2.	IS20112	Environmental Safety	3	0	0	3	40	60	100
3.	IS20113	Occupational Health and Industrial Hygiene	3	0	0	3	40	60	100
4.	MA20135	Applied Statistics	3	0	0	3	40	60	100
5.	IS20115	Industrial Safety, Health and Environment (SHE) Acts	3	0	0	3	40	60	100
6.	IS20116	Human Factors Engineering	3	0	0	3	40	60	100
PRACTICAL									
7.	IS20121	Technical Presentation - I	0	2	0	1	60	40	100
		Total	**18**	**2**	**0**	**19**		**700**	

SEMESTER - II

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	IS20211	Fire Engineering and Explosion Control	3	0	0	3	40	60	100
2.	IS20212	Computer Aided Hazard Analysis	3	0	0	3	40	60	100
3.	IS20213	Electrical Safety	3	0	0	3	40	60	100
4.	IS20214	Reliability Engineering	3	0	0	3	40	60	100
5.	IS20215	Safety in Chemical Industries	3	0	0	3	40	60	100
6.	IS20216	Safety in Engineering Industry	3	0	0	3	40	60	100
PRACTICAL									
7.	IS20221	Industrial Safety Laboratory	0	0	3	2	60	40	100
8.	IS20222	Technical Presentation - II	0	2	0	1	60	40	100
		Total	**18**	**2**	**3**	**21**		**800**	

KSR College of Engineering	**K.S.R. COLLEGE OF ENGINEERING (Autonomous)** (Approved by AICTE, Affiliated to Anna University & Accredited by NAAC with "A++" Grade) **K.S.R. Kalvi Nagar, Tiruchengode - 637 215**	**CURRICULUM** **PG** **R - 2020**

Department	Department of Mechanical Engineering
Programme	M.E. - Industrial Safety Engineering

SEMESTER - III

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	*******	Elective - I	3	0	0	3	40	60	100
2.	*******	Elective - II	3	0	0	3	40	60	100
3.	*******	Elective - III	3	0	0	3	40	60	100
4.	*******	Audit course	2	0	0	0	40	60	100
PRACTICAL									
5.	IS20321	Project Phase - I	0	0	12	6	60	40	100
		Total	**11**	**0**	**12**	**15**	**500**		

SEMESTER - IV

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
PRACTICAL									
1.	IS20421	Project Phase - II	0	0	24	12	60	40	100
		Total	**0**	**0**	**24**	**12**	**100**		

KSR College of Engineering	**K.S.R. COLLEGE OF ENGINEERING (Autonomous)** (Approved by AICTE, Affiliated to Anna University & Accredited by NAAC with "A++" Grade) **K.S.R. Kalvi Nagar, Tiruchengode - 637 215**	**CURRICULUM** **PG** **R - 2020**

Department	Department of Mechanical Engineering
Programme	M.E. - Industrial Safety Engineering

List of Electives

ELECTIVES (SEMESTER - III)

Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
1.	IS20361	Quality Engineering	3	0	0	3	40	60	100
2.	IS20362	Artificial Intelligence and Expert systems	3	0	0	3	40	60	100
3.	IS20363	Work Study and Ergonomics	3	0	0	3	40	60	100
4.	IS20364	Dock Safety	3	0	0	3	40	60	100
5.	IS20365	Safety in Construction	3	0	0	3	40	60	100
6.	IS20366	Transport Safety	3	0	0	3	40	60	100
7.	IS20367	Fireworks safety	3	0	0	3	40	60	100
8.	IS20368	Safety in Powder Handling	3	0	0	3	40	60	100
9.	IS20369	Nuclear Engineering and Safety	3	0	0	3	40	60	100
10.	IS20371	Safety in Textile Industry	3	0	0	3	40	60	100
11.	IS20372	Safety in Mines	3	0	0	3	40	60	100
12.	IS20373	Plant Layout and Materials Handling	3	0	0	3	40	60	100
13.	IS20374	Disaster Management	3	0	0	3	40	60	100
14.	IS20375	OHSAS18000 and ISO14000	3	0	0	3	40	60	100
15.	IS20376	Low Temperature Combustion	3	0	0	3	40	60	100
16.	IS20377	Bio Fuels in IC Engines	3	0	0	3	40	60	100
17.	IS20378	Refrigeration and Cryogenic Engineering	3	0	0	3	40	60	100
18.	IS20379	Energy Conservation and Management	3	0	0	3	40	60	100
19.	IS20380	Refrigeration and Air Conditioning	3	0	0	3	40	60	100
20.	IS20381	Food Processing, Preservation and Transport	3	0	0	3	40	60	100
21.	IS20382	Research Methodology and IPR	3	0	0	3	40	60	100
22.	IS20383	Advanced Materials	3	0	0	3	40	60	100
23.	IS20384	Welding Economics, Management And Safety	3	0	0	3	40	60	100
24.	IS20385	Composite Materials and Mechanics	3	0	0	3	40	60	100
25.	IS20386	Additive Manufacturing	3	0	0	3	40	60	100
26.	IS20387	Advanced Metrology and Non Destructive Testing	3	0	0	3	40	60	100
27.	IS20388	Optimization Techniques In Manufacturing	3	0	0	3	40	60	100
28.	IS20389	Plastics and Composite Materials	3	0	0	3	40	60	100
29.	IS20391	Materials Testing and Characterization Techniques	3	0	0	3	40	60	100
30.	IS20392	Non Destructive Testing and Evaluation	3	0	0	3	40	60	100

AUDIT COURSE (SEMESTER - III)

Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
1.	IS20AU1	English For Research Paper Writing	2	0	0	0	40	60	100

DEPARTMENT OF MECHANICAL ENGINEERING

M.E – INDUSTRIAL SAFETY ENGINEERING

CURRICULUM & SYLLABI

Regulation 2020 (Amendment - 2)

(Applicable to candidates admitted in the academic year 2022 - 2023 (Even Semester) onwards)

Ref. : BOS Meeting No : 09 Dated 06-04-2023

K.S.R. College of Engineering (Autonomous)

(Approved by AICTE, Accredited by NAAC with A++ grade & Affiliated to Anna University)
K.S.R. Kalvi Nagar, Tiruchengode – 637 215

Namakkal (Dt), Tamilnadu, India

Email : info@ksrce.ac.in **Website :** www.ksrce.ac.in

K.S.R. COLLEGE OF ENGINEERING : TIRUCHENGODE - 637 215
(Autonomous)
DEPARTMENT OF INDUSTRIAL SAFETY ENGINEERING

(REGULATION 2020)

Vision of the Institution

IV	We envision to achieve status as an excellent educational institution in the global knowledge hub, making self-learners, experts, ethical and responsible engineers, technologists, scientists, managers, administrators and entrepreneurs who will significantly contribute to research and environment friendly sustainable growth of the nation and the world.

Mission of the Institution

IM 1	To inculcate in the students self-learning abilities that enable them to become competitive and considerate engineers, technologists, scientists, managers, administrators and entrepreneurs by diligently imparting the best of education, nurturing environmental and social needs.
IM 2	To foster and maintain mutually beneficial partnership with global industries and Institutions through knowledge sharing, collaborative research and innovation.

Vision of the Department / Programme: (Industrial Safety Engineering)

DV	To be a centre of excellence in the field of Mechanical Engineering for providing its students and faculty with opportunities for excel in education and targeted research themes in emerging areas.

Mission of the Department / Programme: (Industrial Safety Engineering)

DM 1	To excel in academic and research activities that meet the industrial and social needs.
DM 2	To develop competent, innovative and ethical mechanical Engineers.

Programme Educational Objectives (PEOs) :(Industrial Safety Engineering)

The graduates of the programme will be able to

PEO 1	Enhance the skills and knowledge on safety, health and environment with respect to industry and research, for executing safe methods in complex engineering problems.
PEO 2	Understand the impact of safety, health and environmental solutions on productivity, quality and societal at large.
PEO 3	To comply with legal safety, ethical and contractual requirements, professional practices to contribute the community for the sustainable development of society.

K.S.R. COLLEGE OF ENGINEERING : TIRUCHENGODE - 637 215
(Autonomous)
DEPARTMENT OF INDUSTRIAL SAFETY ENGINEERING

(REGULATION 2020)

PROGRAMME OUTCOMES (POs) AND PROGRAMME SPECIFIC OUTCOMES (PSOs)

Programme Outcomes (POs)	
PO1	An ability to independently carry out research / investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report / document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be a level higher than the requirements in the appropriate bachelor program.
PO4	An ability to attain, identify and apply knowledge of mathematics, soft computing & soft skill and management for various academic and industrial needs.
Programme Specific Outcomes (PSOs)	
PSO1	Students should be able to use techniques and modern engineering tools for engineering practices in their immediate employment and/or entrepreneurial activities.
PSO2	Contribute to the core universal human values and social good to community with respect to industrial safety, health and environment/

K.S.R COLLEGE OF ENGINEERING ,TIRUCHENGODE -637215

DEPARTMENT OF MECHANICAL ENGINEERING

M.E-(INDUSTRIAL SAFETY ENGINEERING)

(REGULATION- 2020) (Amendment-2)

In the curriculum, Five Elective courses were included instead of Two core courses in the Second semester of M.E -Industrial safety Engineering in R2020.This will be applicable from those who admitted in 2022-2023 Batch students for the purpose of provide opportunities to choose the multi specialization area.

SEMESTER - II									
Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	IS20211	Fire Engineering and Explosion Control	3	0	0	3	40	60	100
2.	IS20212	Computer Aided Hazard Analysis	3	0	0	3	40	60	100
3.	IS20213	Electrical Safety	3	0	0	3	40	60	100
4.	IS20214	Reliability Engineering	3	0	0	3	40	60	100
5.	*******	Elective – I	3	0	0	3	40	60	100
6.	*******	Elective – II	3	0	0	3	40	60	100
PRACTICAL									
7.	IS20221	Industrial Safety Laboratory	0	0	3	2	60	40	100
8.	IS20222	Technical Presentation - II	0	2	0	1	60	40	100
		Total	**18**	**2**	**3**	**21**	**800**		

ELECTIVES									
Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
1.	IS20393	Lean Manufacturing	3	0	0	3	40	60	100
2.	IS20394	Advances In Manufacturing Processes	3	0	0	3	40	60	100
3.	IS20395	Smart Manufacturing	3	0	0	3	40	60	100
4.	IS20215	Safety in Chemical Industries	3	0	0	3	40	60	100
5.	IS20216	Safety in Engineering Industry	3	0	0	3	40	60	100

KSR College of Engineering	**K.S.R. COLLEGE OF ENGINEERING (Autonomous)** (Approved by AICTE, Affiliated to Anna University & Accredited by NAAC with "A++" Grade) **K.S.R. Kalvi Nagar, Tiruchengode - 637 215**	**CURRICULUM** **PG** **R - 2020**

Department	Department of Mechanical Engineering
Programme	M.E. - Industrial Safety Engineering

SEMESTER - I

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	IS20111	Principles of Safety Management	3	0	0	3	40	60	100
2.	IS20112	Environmental Safety	3	0	0	3	40	60	100
3.	IS20113	Occupational Health and Industrial Hygiene	3	0	0	3	40	60	100
4.	MA20135	Applied Statistics	3	0	0	3	40	60	100
5.	IS20115	Industrial Safety, Health and Environment (SHE) Acts	3	0	0	3	40	60	100
6.	IS20116	Human Factors Engineering	3	0	0	3	40	60	100
PRACTICAL									
7.	IS20121	Technical Presentation - I	0	2	0	1	60	40	100
		Total	**18**	**2**	**0**	**19**	**700**		

SEMESTER - II

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	IS20211	Fire Engineering and Explosion Control	3	0	0	3	40	60	100
2.	IS20212	Computer Aided Hazard Analysis	3	0	0	3	40	60	100
3.	IS20213	Electrical Safety	3	0	0	3	40	60	100
4.	IS20214	Reliability Engineering	3	0	0	3	40	60	100
5.	*******	Elective – I	3	0	0	3	40	60	100
6.	*******	Elective – II	3	0	0	3	40	60	100
PRACTICAL									
7.	IS20221	Industrial Safety Laboratory	0	0	3	2	60	40	100
8.	IS20222	Technical Presentation - II	0	2	0	1	60	40	100
		Total	**18**	**2**	**3**	**21**	**800**		

KSR College of Engineering	**K.S.R. COLLEGE OF ENGINEERING (Autonomous)** (Approved by AICTE, Affiliated to Anna University & Accredited by NAAC with "A++" Grade) **K.S.R. Kalvi Nagar, Tiruchengode - 637 215**	**CURRICULUM** **PG** **R - 2020**

Department	Department of Mechanical Engineering
Programme	M.E. - Industrial Safety Engineering

SEMESTER - III

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	*******	Elective – III	3	0	0	3	40	60	100
2.	*******	Elective – IV	3	0	0	3	40	60	100
3.	*******	Elective - V	3	0	0	3	40	60	100
4.	*******	Audit course	2	0	0	0	40	60	100
PRACTICAL									
5.	IS20321	Project Phase - I	0	0	12	6	60	40	100
		Total	**11**	**0**	**12**	**15**	**500**		

SEMESTER - IV

Sl.No.	Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
PRACTICAL									
1.	IS20421	Project Phase - II	0	0	24	12	60	40	100
		Total	**0**	**0**	**24**	**12**	**100**		

KSR College of Engineering	**K.S.R. COLLEGE OF ENGINEERING (Autonomous)** (Approved by AICTE, Affiliated to Anna University & Accredited by NAAC with "A++" Grade) **K.S.R. Kalvi Nagar, Tiruchengode - 637 215**	**CURRICULUM** **PG** **R - 2020**

Department	Department of Mechanical Engineering
Programme	M.E. - Industrial Safety Engineering

List of Electives

ELECTIVES (I,II,III,IV,V)

Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
1.	IS20361	Quality Engineering	3	0	0	3	40	60	100
2.	IS20362	Artificial Intelligence and Expert systems	3	0	0	3	40	60	100
3.	IS20363	Work Study and Ergonomics	3	0	0	3	40	60	100
4.	IS20364	Dock Safety	3	0	0	3	40	60	100
5.	IS20365	Safety in Construction	3	0	0	3	40	60	100
6.	IS20366	Transport Safety	3	0	0	3	40	60	100
7.	IS20367	Fireworks safety	3	0	0	3	40	60	100
8.	IS20368	Safety in Powder Handling	3	0	0	3	40	60	100
9.	IS20369	Nuclear Engineering and Safety	3	0	0	3	40	60	100
10.	IS20371	Safety in Textile Industry	3	0	0	3	40	60	100
11.	IS20372	Safety in Mines	3	0	0	3	40	60	100
12.	IS20373	Plant Layout and Materials Handling	3	0	0	3	40	60	100
13.	IS20374	Disaster Management	3	0	0	3	40	60	100
14.	IS20375	OHSAS18000 and ISO14000	3	0	0	3	40	60	100
15.	IS20376	Low Temperature Combustion	3	0	0	3	40	60	100
16.	IS20377	Bio Fuels in IC Engines	3	0	0	3	40	60	100
17.	IS20378	Refrigeration and Cryogenic Engineering	3	0	0	3	40	60	100
18.	IS20379	Energy Conservation and Management	3	0	0	3	40	60	100
19.	IS20380	Refrigeration and Air Conditioning	3	0	0	3	40	60	100
20.	IS20381	Food Processing, Preservation and Transport	3	0	0	3	40	60	100
21.	IS20382	Research Methodology and IPR	3	0	0	3	40	60	100
22.	IS20383	Advanced Materials	3	0	0	3	40	60	100
23.	IS20384	Welding Economics, Management And Safety	3	0	0	3	40	60	100
24.	IS20385	Composite Materials and Mechanics	3	0	0	3	40	60	100
25.	IS20386	Additive Manufacturing	3	0	0	3	40	60	100
26.	IS20387	Advanced Metrology and Non Destructive Testing	3	0	0	3	40	60	100
27.	IS20388	Optimization Techniques In Manufacturing	3	0	0	3	40	60	100
28.	IS20389	Plastics and Composite Materials	3	0	0	3	40	60	100
29.	IS20391	Materials Testing and Characterization Techniques	3	0	0	3	40	60	100
30.	IS20392	Non Destructive Testing and Evaluation	3	0	0	3	40	60	100
31.	IS20393	Lean Manufacturing	3	0	0	3	40	60	100
32.	IS20394	Advances in Manufacturing Processes	3	0	0	3	40	60	100
33.	IS20395	Smart Manufacturing	3	0	0	3	40	60	100
34.	IS20215	Safety in Chemical Industries	3	0	0	3	40	60	100
35.	IS20216	Safety in Engineering Industry	3	0	0	3	40	60	100

AUDIT COURSE (SEMESTER - III)

Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
1.	IS20AU1	English For Research Paper Writing	2	0	0	0	40	60	100

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER -I

		L	T	P	C
IS20111	**PRINCIPLES OF SAFETY MANAGEMENT**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Analyze the concepts and techniques of safety management functions.*	*.Analyze*
CO2:	*Recall about safety audit and to prepare a report for the audit.*	*Understand*
CO3:	*Acquire knowledge on the principles of accident and its control methods.*	*Understand*
CO4:	*Evaluate the accident cost using supervisors report and data.*	*Understand*
CO5:	*Recall the role of various agencies in safety education and training.*	*Understand*

UNIT – I CONCEPTS AND TECHNIQUES [09]

Content Evolution of modern safety concept - Safety Management functions - planning for safety for optimization of productivity -productivity, quality and safety - line and staff functions for safety - safety committee - budgeting for safety - safety policy - Statutory Provisions for safety management.

Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety

UNIT – II SAFETY AUDIT - INTRODUCTION [09]

Components of safety audit, types of audit, audit methodology, non conformity reporting (NCR), audit checklist and report - review of inspection, remarks by government agencies, consultants, experts - perusal of accident and safety records, formats - implementation of audit indication - liaison with departments to ensure co-ordination - check list - identification of unsafe acts of workers and unsafe conditions in the shop floor

UNIT – III SAFETY AUDIT - INTRODUCTION [09]

Basic Principle of Accident & Prevention concept of an accident, reportable and non reportable accidents, reporting to statutory authorities - principles of accident prevention - accident investigation and reporting - Accident analysis - based on causes & injury - records for accidents, departmental accident reports, documentation of accidents - unsafe act and condition - Accident causation theories - domino sequence - supervisory role - role of safety committee - cost of accident

UNIT – IV SAFETY AUDIT - INTRODUCTION [09]

ANSI (Z16.1) Recommended practices for compiling and measuring work injury experience - permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety “t” score, safety activity rate - problems.

UNIT – V SAFETY EDUCATION AND TRAINING [09]

Importance of training - identification of training needs - training methods such as hands on training and tabletop exercise - Programme, seminars, conferences, competitions - method of promoting safe practice – motivation - communication -safety attitude and culture - role of government agencies and private consulting agencies in safety training - creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign - Domestic Safety and Training.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Relevant India Acts and Rules, Government of India.

2 Blake, R.B., Industrial Safety, Prentice Hall Inc, Delhi, Third Edition, 2009.

3 Heinrich, H.W., Industrial Accident Prevention, McGraw-Hill Company, New York, Fifth Edition, 2019.

4 Krishnan, N.V., Safety Management in Industry, Jaico Publishing House, Bombay, Second Edition, 2017.

5 Lees, F.P., Loss Prevention in Process Industries, Butterworth publications, London, Second edition, 2001.

6 John Ridley., Safety at Work, Butterworth and Co, London, Seventh Edition, 2003.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - I

IS20112	**ENVIRONMENTAL SAFETY**	L	T	P	C
		3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Gain about the air pollution effects and its control.*	*Remember*
CO2:	*Analyze about the water pollutants and its health hazards.*	*Analyze*
CO3:	*Apply the health and safety concepts with respect to hazardous waste management.*	*Apply*
CO4:	*Acquire knowledge on environmental measurement and its control.*	*Understand*
CO5:	*Demonstrate the health and safety practices in controlling risks for different engineering activities.*	*Understand*

UNIT – I AIR POLLUTION [09]

Classification and properties of air pollutants - Pollution sources - Effects of air pollutants on human beings, Animals, Plants and Materials - automobile pollution - hazards of air pollution - concept of clean coal combustion technology - ultra violet radiation, infrared radiation, radiation from sun - hazards due to depletion of ozone - deforestation - ozone holes -automobile exhausts - chemical factory stack emissions - CFC Statutory provisions related to air pollution.

UNIT – II WATER POLLUTION [09]

Classification of water pollutants - health hazards - sampling and analysis of water - water treatment - different industrial effluents and their treatment and disposal - advanced wastewater treatment - effluent quality standards and laws - chemical industries, tannery, textile effluents - common treatment - Statutory provisions related to water pollution.

UNIT – III HAZARDOUS WASTE MANAGEMENT [09]

Hazardous waste management in India - waste identification, characterization and classification technological options for collection, treatment and disposal of hazardous waste - selection charts for the treatment of different hazardous wastes - methods of collection and disposal of solid wastes - health hazards - toxic and radioactive wastes - incineration and vitrification - hazards due to bio-process - dilution standards and restrictions - recycling and reuse - statutory provisions related to hazardous waste management & handling.

UNIT – IV ENVIRONMENTAL MEASUREMENT AND CONTROL [09]

Sampling and analysis - dust monitor - gas analyzer, particle size analyzer - Lux meter - pH meter - gas chromatograph - atomic absorption spectrometer. Gravitational settling chambers - cyclone separators - scrubbers - electrostatic precipitator - bag filter - maintenance - control of gaseous emission by adsorption, absorption and combustion methods -Pollution Control Board - laws.

UNIT – V POLLUTION CONTROL IN PROCESS INDUSTRIES [09]

Pollution control in process industries like cement, paper and petroleum - petroleum products - textile - tanneries thermal power plants - dying and pigment industries - eco-friendly energy

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Rao, C.S. ,Environmental Pollution Engineering, Wiley Eastern Limited, New Delhi, Third Edition, 2020.

2 Mahajan, S.P., Pollution Control in Process Industries, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition, 2001.

3 Rao, C.S., Environmental Pollution Engineering, Wiley Eastern Limited, New Delhi, Third Edition, 2020.

4 Mahajan, S.P. ,Pollution Control in Process Industries, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition, 2001.

5 Varma and Braner, Air Pollution Equipment, Springer Publishers, New Delhi, Second Edition, 2017.

6 Rao, C.S., Environmental Pollution Engineering, Wiley Eastern Limited, New Delhi, Third Edition, 2020.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER -I

		L	T	P	C
IS20113	**OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Acquire knowledge on the various physiological functions of our body, their effects and control.*	*Understand*
CO2:	*Recall the various types of chemical hazards and their control methods.*	*Understand*
CO3:	*Analyze the various types of occupational diseases arising out of biological agents.*	*Analyze*
CO4:	*Demonstrate effectively about the occupational health and toxic nature among the employees and with society at large.*	*Apply*
CO5:	*Recall about the physiology of work with the working environment.*	*Understand*

UNIT – I PHYSICAL HAZARDS [09]

Noise, types, Industrial noise, compensation aspects, noise exposure regulation and control, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control programmes, industrial audiometry, hearing conservation programmes.

Vibration, types, effects, instruments, surveying procedure, permissible exposure limit and control.

Ionizing radiation, types, effects, monitoring instruments, control programmes, OSHA standard - non-ionizing radiations, effects, types, radar hazards, microwaves and radio-waves, lasers TLV - cold environments, hypothermia, wind chill index, control measures - hot environments, thermal comfort, heat stress indices, acclimatization, estimation and control.

UNIT – II CHEMICAL HAZARDS [09]

Recognition of chemical hazards - dust, fumes, mist, vapor, fog, gases, types, concentration, Exposure vs dose, TLV - Methods of Evaluation, process or operation description, field survey, sampling methodology, Industrial hygiene calculations, Comparison with OSHAS Standard.

Air Sampling instruments, types, measurement procedures, instruments procedures, gas and vapor monitors, dust sample collection devices, personal sampling.

Methods of Control - engineering control, design, maintenance considerations, design specifications - general control methods - training and education

UNIT – III BIOLOGICAL AND ERGONOMICAL HAZARDS [09]

Classification of Bio-hazardous agents - examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents and infectious diseases - biohazard control programmes, employee health programmes - laboratory safety programmes - animal care and handling - biological safety cabinets - building design.

Work Related Musculoskeletal Disorders - carpal tunnel syndrome (CTS) - Tendon pain - disorders of the neck - back injuries.

UNIT – IV OCCUPATIONAL HEALTH AND TOXICOLOGY [09]

Concept and spectrum of health - functional units and activities of occupational health services, pre - employment and post - employment medical examinations - occupational related diseases, levels of prevention of diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax.

Lead - nickel, chromium and manganese toxicity, gas poisoning (such as CO, ammonia, coal and dust etc) their effects and prevention - cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests.

Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems.

UNIT – V OCCUPATIONAL PHYSIOLOGY [09]

Man as a system component - allocation of functions - efficiency - occupational work capacity - aerobic and anaerobic work - evaluation of physiological requirements of jobs - parameters of measurements - categorization of job heaviness - work organization - stress - strain – fatigue - rest pauses - shift work - personal hygiene

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Hand book of Occupational Safety and Health, National Safety Council, Chicago, Second Edition, 2012.

2 Encyclopedia of Occupational Health and Safety, Vol - I and II, International Labour Office, Geneva, Fourth Edition, 1985.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER – I

		L	T	P	C
MA20135	**APPLIED STATISTICS**				
	(M.E. Industrial Safety Engineering)	3	0	0	3

Course Outcomes : Upon Completion of the course, the students should be able to : **Cognitive Level**

CO1	*Develop the skills in random variable and its Distributions.*	*Remember*
CO2	*Develop the skills in Estimation theory and interpretation of correlation and regression analysis*	*Remember*
CO3	*Extend knowledge in testing the significance between the samples.*	*Understand*
CO4	*Interpret the variances and finding the significance by using Design of Experiments.*	*Apply*
CO5	*Compute the control charts and finding various types of inferences.*	*Evaluate*

UNIT – I RANDOM VARIABLES [9]

One dimensional and Two-dimensional Random variables – Moments – Moment generating function – Standard distributions - Binomial, Poisson, Normal and Exponential distributions..

UNIT – II CORRELATION, REGRESSION AND ESTIMATION THEORY [9]

Correlation and Regression - Multiple and Partial correlations - Principle of least squares- Fitting straight line trends. Estimation of Parameters – Maximum likelihood estimates – Method of moments.

UNIT - III TESTING OF HYPOTHESIS [9]

Sampling distributions - Type I and Type II errors – Test of significance for small sample (Student's t- test) - Test of significance for large samples (z-test) – Test of significance of variance (F- test) – Chi-Square test for Independence of attributes.

UNIT - IV DESIGN OF EXPERIMENTS [9]

Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design –Latin square design.

UNIT – V QUALITY CONTROL [9]

Introduction – Types of control Charts – X chart – R chart – Control chart for the standard deviations σ-chart – Control chart for C (Number of defects per unit) – Advantage and limitation of Statistical Quality Control.

Total =45 Periods

Reference Books :

1 S.P. Gupta ,Statistical Methods, Sultan Chand & sons, New Delhi, Thirty first edition, 2014.

2 Freund John, E and Miller, Irvin, Probability and Statistics for Engineering, Prentice Hall, New Delhi, Fifth Edition, 2013.

3 Gupta, S.C and Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi, Fourteenth edition, 2014.

4 Eugene L. Grant and Richard S. Leavenworth, Statistical Quality Control, McGraw-Hill Publications, New York, Seventh edition, 2013.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER -I

		L	T	P	C
IS20115	**INDUSTRIAL SAFETY, HEALTH AND ENVIRONMENT (SHE) ACTS**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Gain the health and welfare provisions as given in factories act*	*. Understand*
CO2:	*Acquire knowledge on environment act with respect to air and water pollution.*	*Understand*
CO3:	*Analyze the responsibilities of occupier according to manufacture, storage and import of chemical rules*	*Analyze*
CO4:	*Evaluate the other legislation acts pertaining to health and safety.*	*Evaluate*
CO5:	*List out the various international acts and rules.*	*Remember*

UNIT – I FACTORIES ACT - 1948 [09]

Statutory authorities - inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young person's - special provisions - penalties and procedures - Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948, forms, registers and notices - Amendments.

UNIT – II ENVIRONMENT ACT - 1986 [09]

General powers of the central government, prevention, control and abatement of environmental pollution - Biomedical waste (Management and Handling) Rules, 1989 - The Noise Pollution (Regulation and control) Rules, 2000 - The Batteries (Management and Handling) Rules, 2001 - No Objection certificate from statutory authorities like pollution control board.

Air Act 1981 and Water Act 1974:Central and state boards for the prevention and control of air pollution - powers and functions of boards - prevention and control of air pollution and water pollution – fund - accounts and audit, penalties and procedures**.**

UNIT – III MANUFACTURE, STORAGE AND IMPORT OF CHEMICAL RULES 1989 [09]

Definitions - duties of authorities - responsibilities of occupier - notification of major accidents - information to be furnished - preparation of offsite and onsite plans - list of hazardous and toxic chemicals - safety reports - safety data sheets.

UNIT – IV OTHER ACTS AND RULES [09]

Indian Boiler Act 1923, Static and Mobile Pressure Vessel Rules (SMPV), Motor Vehicle Rules, Mines Act 1952, Workman Compensation Act, Rules - Electricity Act and Rules - Hazardous Wastes (Management and Handling) Rules, 1989, with amendments in 2000 - The Building and Other Construction Workers Act 1996., Petroleum rules, Gas cylinder rules - Explosives Act 1983 - Pesticides Act.

UNIT – V INTERNATIONAL ACTS AND STANDARDS [09]

Occupational Safety and Health Act of USA (The Williams - Steiger Act of 1970) - Health and Safety Work Act (HASAWA) 1974, UK - SHAS 18001 - ISO 45001 - American National Standards Institute (ANSI).

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 The Factories Act 1948, Madras Book Agency, Chennai, 2000.

2 The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt. Ltd., New Delhi, Second Edition, 2019.

3 The Indian boilers act 1923, Commercial Law Publishers (India) Pvt. Ltd., Allahabad, Second Edition, 2011.

4 The Mines Act 1952, Commercial Law Publishers (India) Pvt. Ltd., Allahabad, Second Edition, 2019.

5 National seminar on hazardous waste management ,National Safety council, Ministry of environment and forests, Government of India, United State - Asia environmental partnership, Tamilnadu pollution control board and Indian chemical manufacturers association, April 2009.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER -I

		L	T	P	C
IS20116	**HUMAN FACTORS ENGINEERING**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Acquire knowledge on ergonomics and its area of application.*	*Understand*
CO2:	*Gain about human behaviour, behaviour based system and ABC theory.*	*Understand*
CO3:	*Apply the concept of anthropometry and work design for standing and seated works.*	*Apply*
CO4:	*Analyze the man machine system and manual handling task and its hazards*	*.Analyze*
CO5:	*Recall the principles for the design of visual displays and design of controls*	*. Remember*

UNIT – I ERGONOMICS AND ANATOMY [09]

Introduction to ergonomics: The focus of ergonomics, ergonomics and its areas of application in the work system, a brief history of ergonomics, attempts to humanize work, modern ergonomics, future directions for ergonomics.

Anatomy, Posture and Body Mechanics: Some basic body mechanics, anatomy of the spine and pelvis related to posture, posture stability and posture adaptation, low back pain, risk factors for musculoskeletal disorders in the workplace, behavioral aspects of posture, effectiveness and cost effectiveness, research directions.

UNIT – II HUMAN BEHAVIOR [09]

Individual differences, Factors contributing to personality, Fitting the man to the job, Influence of difference on safety, Method of measuring characteristics, Accident Proneness. Motivation, Complexity of Motivation, Job satisfaction. Management theories of motivation, Job enrichment theory. Frustration and Conflicts, Reaction to frustration, Emotion and Frustration. Attitudes, determination of attitudes, changing attitudes, learning, principles of learning, forgetting, motivational requirements.

UNIT – III ANTHROPOMETRY AND WORK DESIGN FOR STANDING AND SEATED WORKS [09]

Designing for a population of users, percentile, sources of human variability, anthropometry and its uses in ergonomics, principals of applied anthropometry in ergonomics, application of anthropometry in design, design for everyone, anthropometry and personal space, effectiveness and cost effectiveness. Fundamental aspects of standing and sitting, an ergonomics approach to work station design, design for standing workers, design for seated workers, work surface design, visual display units, guidelines for design of static work, effectiveness and cost effectiveness, research directions.

UNIT – IV MAN - MACHINE SYSTEM AND REPETITIVE WORKS AND MANUAL HANDLING TASK [09]

Applications of human factors engineering, man as a sensor, man as information processor, man as controller – Man vs Machine. Ergonomics interventions in Repetitive works, handle design, key board design- measures for preventing in work related musculoskeletal disorders (WMSDs), reduction and controlling, training Anatomy and biomechanics of manual handling, prevention of manual handling injuries in the work place, design of manual handling tasks, carrying, postural stability.

UNIT – V HUMAN SKILL & PERFORMANCE AND DISPLAY, CONTROLS AND VIRTUAL ENVIRONMENTS [09]

A general information-processing model of the users, cognitive system, problem solving, effectiveness. Principles for the design of visual displays - auditory displays - design of controls - combining displays and controls - virtual (synthetic) environments, research issues.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Mark S Sanders, Ernest J Mc Cormick., Human Factors In Engineering & Design, McGraw - hill Book Company – Koga, Seventh Edition, 2019.

2 Bridger, R.S.,Introduction to Ergonomics, Taylor & Francis, UK, second edition, 2018.

3 Dan Mc Leod, The Ergonomics Manual, Philip Jacobs & Nancy Larson, New Delhi, Second Edition, 2013.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - I

		L	T	P	C
IS20121	**TECHNICAL PRESENTATION - I**	0	2	0	1

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Able to identify the problems in general area of interest by the student.*	*Understand*
CO2:	*Incorporate the area / problem by referring journals, conference proceedings etc.*	*Remember*
CO3:	*Enhance the collective skills between theoretical knowledge and real time problems.*	*Understand*
CO4:	*Gain knowledge on the problem by presentation and review.*	*Remember*
CO5:	*Acquire idea on report writing and presentation.*	*Understand*

1. The students have to refer the journals and conference proceedings and collect the published literature.
2. By mutual discussions with the faculty in-charge the student can decide a topic in general.
3. The student is expected to collect at least 20 such research papers published in the last 5 years.
4. Using OHP / Power Point, the student has to make presentation for 20 minutes followed by 10 minutes discussion.
5. The student has to make five presentations in the semester.
6. The student has to write a technical report for about 30 - 50 pages (Title page, One page Abstract, Review of Research paper under various sub - headings, concluding remarks and list of references). The technical report has to be submitted to the course coordinator one week before the final presentation.

Total = 30 Periods

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - II

		L	T	P	C
IS20211	**FIRE ENGINEERING AND EXPLOSION CONTROL**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Recall about the fire properties of solid, liquid and gases and understand the principle of fire and combustion Theory.*	*Understand*
CO2:	*Gain knowledge about the fire prevention and fire protection systems.*	*Understand*
CO3:	*Acquire knowledge on different sources of ignition, classes of fires and their extinguishing medium*	*. Understand*
CO4:	*Ability to know the objective of building fire safety and relevant standards.*	*Understand*
CO5:	*Apply the principles of explosion and understand about their protecting systems.*	*Apply*

UNIT – I PHYSICS AND CHEMISTRY OF FIRE [09]

Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - theory of combustion and explosion - vapour clouds - flash fire - jet fires - pool fires - unconfined vapour cloud explosion, shock waves - auto - ignition - boiling liquid expanding vapour explosion - case studies - Flixborough, Mexico disaster, Pasadena Texas, Piper Alpha, Peterborough & Bombay Victoria dock ship explosions.

UNIT – II FIRE PREVENTION AND PROTECTION [09]

Sources of ignition - fire triangle - principles of fire extinguishing - active and passive fire protection systems - various classes of fires - A, B, C, D - types of fire extinguishers - fire stoppers - hydrant pipes – hoses - monitors - fire watchers - layout of stand pipes - fire station - fire alarms and sirens - maintenance of fire trucks - foam generators - escape from fire rescue operations - fire drills - notice - first aid for burns.

UNIT – III INDUSTRIAL FIRE PROTECTION SYSTEMS [09]

Sprinkler - hydrants - stand pipes - special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards - alarm and detection systems. Other suppression systems - CO_2 system, foam system, dry chemical powder (DCP) system and halon system - need for halon replacement - smoke venting. Portable extinguishers - flammable liquids - tank farms - indices of inflammability - fire fighting

UNIT – IV BUILDING FIRE SAFETY [09]

Objectives of fire safe building design, fire load, fire resistant material and fire testing - structural fire protection - structural integrity - concept of egress design - exits - width calculations - fire certificates - fire safety requirements for high rise buildings - snookers.

UNIT – V EXPLOSION PROTECTING SYSTEMS [09]

Principles of explosion - detonation and blast waves - explosion parameters - Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure - explosion venting - inert gases, plant for generation of inert gas - rupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO 2) and halons - hazards in LPG, ammonia (NH_3), sulphur dioxide (SO_3), chlorine (Cl_2) etc.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Derek, James, Fire Prevention Hand Book, Butter Worths and Company, London, Ninth edition, 2016 .
2 Gupta, R.S., Hand Book of Fire Technology, Orient Longman, Bombay, Second Edition, 1993.
3 Accident Prevention manual for industrial operations, N.S.C., Chicago, Second Edition,1982.
4 DinkoTuhtar, Fire and explosion Protection, E. Horwood, Second Edition, 1989
5 Davis Daniel et al, Hand Book of fire technology.
6 Fire fighters hazardous materials reference book for Fire Prevention in Factories, Van Nostrand Rein Hold, Second Edition, New York, 1991.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER -II

		L	T	P	C
IS20212	**COMPUTER AIDED HAZARD ANALYSIS**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Explore the basic concepts in risk and hazard assessment.*	*Understand*
CO2:	*Analyze the use of different types of instruments for various testing.*	*Analyze*
CO3:	*Apply the risk assessment technique to quantify the risk using different software.*	*Apply*
CO4:	*Determine the consequence analysis for plotting the damages towards hazardous situations.*	*Evaluate*
CO5:	*Demonstrate the various types of disasters based on past accident analysis.*	*Remember*

UNIT – I HAZARD, RISK ISSUES AND HAZARD ASSESSMENT [09]

Introduction, hazard, hazard monitoring - risk issue, group or societal risk, individual risk, voluntary and involuntary risk, social benefits Vs technological risk, approaches for establishing risk acceptance levels, risk estimation. Hazard assessment, procedure, methodology, safety audit, checklist analysis, what - if analysis, safety review, Preliminary Hazard Analysis (Pre HA), human error analysis, Hazard Operability studies (HAZOP), safety warning systems.

UNIT – II COMPUTER AIDED INSTRUMENTS [09]

Applications of Advanced Equipments and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter(DSC), Thermo Gravimetric Analyzer(TGA), Accelerated Rate Calorimeter(ARC), Reactive Calorimeter(RC), Reaction System Screening Tool(RSST) - Principles of operations, Controlling parameters, applications, advantages. Explosive Testing, Deflagration Test, Detonation Test, Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test(BAM) and Friction Sensitiveness Test (BAM), Shock Sensitiveness Test, Card Gap Test.

UNIT – III RISK ANALYSIS QUANTIFICATION AND SOFTWARES [09]

Fault Tree Analysis & Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - Fire Explosion and Toxicity Index (FETI), various indices - Hazard Analysis(HAZAN) - Failure Mode and Effect Analysis(FMEA), Layer of Protection Analysis(LOPA) and Safety integrity level(SIL) - Software on Risk analysis, ALOHA, Hamsagars modules on Heat radiation, Pool fire, Jet, Explosion. Reliability software on FMEA for mechanical and electrical systems.

UNIT – IV CONSEQUENCES ANALYSIS [09]

Logics of consequences analysis - Estimation - Hazard identification based on the properties of chemicals - Chemical inventory analysis - identification of hazardous processes - Estimation of source term, Gas or vapour release, liquid release, two phase release - Heat radiation effects, BLEVE, Pool fires and Jet fire – Gas / vapour dispersion - Explosion, UVCE and Flash fire, Explosion effects and confined explosion - Toxic effects - Plotting the damage distances on plot plant / layout.

UNIT – V CREDIBILITY OF RISK ASSESSMENT TECHNIQUES [09]

Past accident analysis as information sources for Hazard analysis and consequences analysis of chemical accident, Mexico disaster, Flixborough, Bhopal, Seveso, Pasadena, Feyzin disaster (1966), Port Hudson disaster,Vizag HPCL 1997 incident,LG Polymer Vizag incident 2020- convey report, hazard assessment of non-nuclear installation - Rijnmond report, risk analysis of size potentially Hazardous Industrial objects - Rasmussen masses report, Reactor safety study of Nuclear power plant.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Frank P. Less, Loss Prevention in Process Industries, Butterworth -Hein UK 1990 (Vol.I, II & III), UK ,Third edition , 2005

2 Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK, 1990.

3 Course Material – Intensive Training Programme on Consequence Analysis, Process Safety Centre, Indian Institute of Chemical Technology, Tarnaka& CLRI, Chennai, Second Edition, 1987.

4 Major Hazard control- A practical Manual, ILO, Geneva, Third Edition, 1993.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - II

		L	T	P	C
IS20213	**ELECTRICAL SAFETY**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Familiarize the basic concepts in electrical circuit and hazards involved in it.*	*Remember*
CO2:	*Analyze the different types of electrical hazards in industries*	*. Analyze*
CO3:	*Acquire knowledge about the different types of protection systems.*	*Understand*
CO4:	*Apply the knowledge in the selection, installation, operation and maintenance of portable tools*	*. Apply*
CO5:	*Classify the different hazardous zones in Industries.*	*Understand*

UNIT – I CONCEPTS AND STATUTORY REQUIREMENTS [09]

Introduction - electrostatics, electro magnetism, stored energy, energy radiation and electromagnetic interference - Working principles of electrical equipment - Indian electricity act and rules - statutory requirements from electrical inspectorate - International standards on electrical safety - first aid - cardio pulmonary resuscitation(CPR).

UNIT – II ELECTRICAL HAZARDS [09]

Primary and secondary hazards - shocks, burns, scalds, falls - human safety in the use of electricity.

Energy leakage - clearances and insulation - classes of insulation - voltage classifications - excess energy - current surges - Safety in handling of war equipments - over current and short circuit current - heating effects of current - electromagnetic forces - corona effect - static electricity - definition, sources, hazardous conditions, control, electrical causes of fire and explosion - ionization, spark and arc-ignition energy - national electrical safety code ANSI.High voltage Hazards,

Lightning, hazards, lightning arrestor, installation - earthing, specifications, earth resistance, earth pit maintenance.

UNIT – III PROTECTION SYSTEMS [09]

Fuse, circuit breakers and overload relays - protection against over voltage and under voltage - safe limits of amperage – voltage - safe distance from lines - capacity and protection of conductor - joints and connections, overload and short circuit protection - no load protection - earth fault protection.

FRLS insulation - insulation and continuity test - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - cable wires - maintenance of ground - ground fault circuit interrupter - use of low voltage - electrical guards - Personal protective equipment - safety in handling hand held electrical appliances tools and medical equipments.

UNIT – IV SELECTION, INSTALLATION, OPERATION AND MAINTENANCE [09]

Role of environment in selection - safety aspects in application - protection and interlock - self diagnostic features and fail safe concepts - lock out and work permit system - discharge rod and earthing devices - safety in the use of portable tools - cabling and cable joints - preventive maintenance.

UNIT – V HAZARDOUS ZONES [09]

Classification of hazardous zone - Intrinsically safe and explosion proof electrical apparatus - increase safe equipment -their selection for different zones - temperature classification - grouping of gases - use of barriers and isolators -equipment certifying agencies.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Dr.Massim A.G. Mitolo., Electrical safety of Low voltage systems, Mc Graw Hill, Second Edition, 2009
2 Accident prevention manual for industrial operations, N.S.C., Chicago, Third edition,2008.
3 Fordham Cooper, W., Electrical Safety Engineering., Butterworth and Company, London, Third edition,2002
4 Accident prevention manual for industrial operations, N.S.C., Chicago, Third edition, 2008.
5 Indian Electricity Act and Rules, Government of India, 2003
6 Power Engineers – Handbook of TNEB, Chennai, 1989.
7 Martin Glove Electrostatic Hazards in powder handling, Research Studies Pvt Ltd., England, Second Edition,1988.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER – II

IS20214	RELIABILITY ENGINEERING	L	T	P	C
		3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Gain knowledge about the priori and post priori concepts, mortality curve and ability to calculate the system effectiveness.*	*Understand*
CO2:	*Acquire knowledge on failure data analysis and their limitations.*	*Understand*
CO3:	*Apply the principles of reliability prediction models and its applications.*	*Understand*
CO4:	*Analyze about the improvement of components and their computational procedures.*	*Apply*
CO5:	*Determine the objectives of reliability and quality management approaches.*	*Analyze*

UNIT – I RELIABILITY CONCEPT [09]

Reliability function - failure rate - mean time between failures (MTBF) - mean time to failure (MTTF) - A priori and a posteriori concept - mortality curve - useful life – availability – maintainability - system effectiveness.

UNIT – II FAILURE DATA ANALYSIS [09]

Time to failure distributions - Exponential, Normal, Gamma, Weibull - ranking of data - probability plotting techniques - Hazard plotting.

UNIT – III RELIABILITY PREDICTION MODELS [09]

Series and parallel systems - RBD approach - Standby systems - Application of Bayes' theorem - cut and tie set method - Markov analysis - Fault Tree Analysis - limitations.

UNIT – IV RELIABILITY IMPROVEMENT [09]

Introduction - Improvement of components - Element, Unit, Standby Redundancies - Redundancy Optimization - Computational Procedures.

UNIT – V RELIABILITY MANAGEMENT [09]

Integrated reliability programs - Management policies and decisions - Reliability Management by objectives - Managing people for reliability - Managing lower level suppliers - Customer management - Quality management approaches -Reliability data acquisition and analysis - Life cycle costs - Reliability allocation.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Srinath L.S, Reliability Engineering, Affiliated East-West Press Pvt Ltd, New Delhi, Fourth Edition, 2005.

2 Patrick O Connor, Reliability Engineering John Wiley & Sons, Ltd, New Delhi, Fifth Edition, 2006.

3 Balagurusamy. E., Reliability Engineering, Tata McGraw Hill Education Pvt Ltd, Ninth Edition, New Delhi, Second Edition, 1984.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - II

		L	T	P	C
IS20221	**INDUSTRIAL SAFETY LABORATORY**	0	0	3	2

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Analyze about the various equipments to bring out the safety environment in the industry.*	*Analyze*
CO2:	*Gain knowledge about the various sources of particular matter and assess the impact of air pollution.*	*Understand*
CO3:	*Learn about the usage of fire extinguishers and its operation.*	*Understand*
CO4:	*Acquire knowledge on insulation and earth resistance.*	*Understand*
CO5:	*Demonstrate the use of software and hence to predict the real situations on major accidents.*	*Evaluate*

LIST OF EXPERIMENTS

1. Carryout the Noise level Measurement for a given area and compare with the standards.
2. Find the illumination level of a given area using the Lux meter.
3. Find the percentage of CO_2, CO, SO_2 and O_2 present in the exhaust gas of a given diesel/petrol engine using Exhaust gas analyzer under different loading conditions.
4. Find the total mass of the suspended particulate matter in a given area using the respirable dust sampler.
5. Determine the earth resistance and resistivity by using the earth resistance for the given soil.
6. Find the insulation resistance for the given motor and cable using insulation tester.
7. Identify the given PPE's and explain in detail about its usage.
8. Identify the various types of fire extinguishers and elaborate in detail about its operation and method of extinguishing.
9. Find the toxic and flammable level of the given chemical using dispersion modeling (ALOHA) software.
10. What is meant by First-aid and what are the items to be kept in the first-aid box? Explain briefly.

LIST OF EQUIPMENTS

1. Noise level meter - 1 no.
2. Lux meter - 1 no.
3. Exhaust gas analyzer - 1 no.
4. Respirable dust sampler - 1 no.
5. Earth resistance tester - 1 no.
6. Insulation tester - 1 no.
7. PPE set - 1 no.
8. Fire extinguisher set - 1 no.
9. ALOHA Software (*on-line – trial version) - 1 no.
10. First-aid kit - 1 no.

Total = 45 Periods

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - II

		L	T	P	C
IS20222	**TECHNICAL PRESENTATION - II**	0	2	0	1

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Identify the problems in general area of interest by the student.*	*Understand*
CO2:	*Explore the area / problem by referring journals, conference proceedings etc.*	*Understand*
CO3:	*Enhance the collective skills between theoretical knowledge and real time problems.*	*Understand*
CO4:	*Gain knowledge on the area by presentation and review.*	*Understand*
CO5:	*Acquire idea on report writing and presentation related to the area.*	*Understand*

- The students have to refer the journals and conference proceedings and collect the published literature.
- By mutual discussions with the faculty in-charge the student can decide a topic related to area /subject.
- The student is expected to collect at least 20 such research papers published in the last 5 years.
- Using OHP / Power Point, the student has to make presentation for 20 minutes followed by 10 minutes discussion.
- The students should visit an industry, has to make five presentations and a report of the same in the semester.
- The student has to write a technical report for about 30 - 50 pages (Title page, One page Abstract, Review of Research paper under various sub - headings, concluding remarks and list of references). The technical report has to be submitted to the course coordinator one week before the final presentation, after the approval of the faculty in-charge.

Total = 30 Periods

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20361	**QUALITY ENGINEERING (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Acquire knowledge on quality objectives, quality control and knows the importance of quality assurance.*	*Understand*
CO2:	*Analyze about the online quality control and its measurement.*	*Analyze*
CO3:	*Determine about the online quality control attributes and methods for process improvement.*	*Understand*
CO4:	*Apply the concept of preventive maintenance schedule and TPM.*	*. Apply*
CO5:	*Gain knowledge on six sigma and its implementation.*	*Understand*

UNIT - I INTRODUCTION TO QUALITY ENGINEERING AND LOSS FUNCTION [9]

Quality value and engineering - overall quality system - quality engineering in product design - quality engineering in design of production processes - quality engineering in production - quality engineering in service. Loss function derivation - use - loss function for products / system - justification of improvements - loss function and inspection - quality evaluations and tolerances - N type, S type, L type.

UNIT - II ON-LINE QUALITY CONTROL [9]

On-line feedback quality control variable characteristics - control with measurement interval - one unit, multiple units -control systems for lot and batch production. On-line process parameter control variable characteristics - process parameter tolerances feedback control systems - measurement error and process control parameters.

UNIT - III ON-LINE QUALITY CONTROL ATTRIBUTES AND METHODS FOR PROCESS IMPROVEMENT [9]

Checking intervals - frequency of process diagnosis. Production process improvement method - process diagnosis improvement method - process adjustment and recovery improvement methods.

UNIT - IV QUALITY ENGINEERING AND TPM [9]

Preventive maintenance schedules - PM schedules for functional characteristics - PM schedules for large scale systems. Quality tools - fault tree analysis, event tree analysis, failure mode and effect analysis - ISO quality systems.

UNIT - V SIX SIGMA AND ITS IMPLEMENTATION [9]

Introduction - definition - methodology - impact of implementation of six sigma - DMAIC method - roles and responsibilities - leaders, champion, black belt, green belts. Do's and dont's - readiness of organization - planning - management role - six sigma tools - sustaining six sigma.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Rachel Silvestrini, Sarah E. Burke, The Certified Quality Engineering Handbook, ASQ Quality Press, New Delhi, 2017.

2 De Feo, J A and Barnard, W., Six Sigma: Breakthrough and Beyond, Tata McGraw- Hill, New Delhi, Second Edition, 2005.

3 Brue, G., Six Sigma for Managers, Tata-McGraw Hill, New Delhi, Second Reprint, 2002.

4 Pyzdek, T and Berger, R.W., Quality Engineering Handbook, Tata-McGraw Hill, New Delhi, Second Edition, 1996.

5 Taguchi, G, Elsayed, E.A and Hsiang, T.C., Quality Engineering in Production Systems, Mc-Graw Hill Book company, Singapore, International Edition, 1989.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20362	**ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Explore about the measuring intelligence, historical back ground and its applications.*	*Understand*
CO2:	*Recall the cognitive psychology for identifying real objects and factory vision systems*	*Understand*
CO3:	*Acquire knowledge engineering based on fuzzy logic and sematic networks.*	*Remember*
CO4:	*Apply the concept of expert system for knowledge acquisition, system structure and its applications.*	*Apply*
CO5:	*Familiarize about the neural network architecture and its learning methods.*	*Understand*

UNIT - I INTRODUCTION [9]

Intelligence - definition, types cognitive aspect approach, measuring intelligence - early efforts, IQ and AI: aspects of intelligence - learning, problem solving, creativity, behavior and biology. Artificial intelligence: Historical background, applications of AI, objections and myths, AI languages: Introduction to PROLOG and LISP.

UNIT - II COGNITIVE PSYCHOLOGY [10]

The mind - informative and cybernetics, components for thought, modes of perception - visual, auditory and other systems: memory mechanisms, problem solving - planning, search, the GPS systems; types of learning - rote, parameter, method and concept: Game playing, reasoning, Artificial Vision - picture processing - identifying real objects; Vision programs, factory vision systems.

UNIT - III KNOWLEDGE ENGINEERING [10]

Introduction - role of knowledge engineer, knowledge representation - psychology, production rules, logic and programming, Common sense and fuzzy logic, semantic networks, learning systems.

UNIT - IV EXPERT SYSTEMS [9]

Introduction, knowledge acquisition for expert system, features of expert systems - system structure, inference engines, uncertainties, memory mechanisms, range of applications, actual expert systems - VP expert. Assignment - development of a simple expert system.

UNIT - V INTRODUCTION TO NEURAL NETWORKS [7]

Neural Network Architecture - Learning methods - Architecture of a Back Propagation Network - Selection of parameters - Simple variation of BPN.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Elaine, R., Kevin and Shivashankar B Nair., Artificial Intelligence 3E (Sie), Tata McGraw Hill, US, Third Edition, 2019.

2 Rajasekaran, S and Vijayalakshmi Pai., G.A, Neural Networks, Fuzzy Logic and Evolutionary Algorithms - Synthesis and Applications, PHI, Second Edition, 2017.

3 Rajendra Akerkar., Introduction to Artificial Intelligence., PHI Learning , Second Edition, 2014.

4 Dan W.Patterson., Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, New Delhi, Third revision, 1992.

5 Winston, P.H., Artificial Intelligence, Addison Wesley, UK, Third Edition, 1990.

6 Nilsson, N.J., Principles of AI, Narosa Publishing House, UK, Reprint, 1990.

7 Charnaik, E., and McDermott, D., Introduction to Artificial Intelligence, Addison Wesley, UK, Second Edition, 1985.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20363	**WORK STUDY AND ERGONOMICS (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Familiarize on work study and study of operation and its application.*	*Understand*
CO2:	*Analyze about applications of ergonomic principle in the shop floor and physiology of workers.*	*Analyze*
CO3:	*Explore the concepts of PPE's and its ergonomic considerations.*	*Understand*
CO4:	*Recall about various machine tools, process and equipment design.*	*Understand*
CO5:	*Acquire knowledge on man-machine systems.*	*Understand*

UNIT - I WORK STUDY [09]

Study of operations - work content - work procedure - breakdown - human factors - safety and method study - methods and movements at the workplace - substitution with latest devices - robotic concepts - applications in hazardous workplaces - productivity, quality and safety (PQS).

UNIT - II ERGONOMICS [09]

Definition - applications of ergonomic principles in the shop floor - work benches - seating arrangements - layout of electrical panels - switch gears - principles of motion economy - location of controls - display locations - machine foundations - work platforms, fatigue, physical and mental strain - incidents of accident - physiology of workers.

UNIT - III PERSONAL PROTECTION [09]

Concepts of personal protective equipment - types - selection of PPE - invisible protective barriers - procurement, storage, inspection and testing - quality - standards - ergonomic considerations in personal protective equipment design.

UNIT - IV PROCESS AND EQUIPMENT DESIGN [09]

Process design - equipment – instrument - selection - concept modules - various machine tools - in-built safety - machine layout - machine guarding - safety devices and methods - selection, inspection, maintenance and safe usage - statutory provisions, operator training and supervision - hazards and prevention.

UNIT - V MAN MACHINE SYSTEMS [09]

Job and personal risk factors - standards - selection and training - body size and posture - body dimension (static/dynamic) - adjustment range – penalties - guide lines for safe design and postures - evaluation and methods of reducing posture strain. Man-machine interface - controls - types of control - identification and selection - types of displays - compatibility and stereotypes of important operations - fatigue and vigilance - measurement characteristics and strategies for enhanced performance.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Lakhwinder Pal Singh, Work Study and Ergonomics, 2018.
2 Work Study, National Productivity Council, New Delhi, 1995.
3 Introduction to Work Study, ILO, Oxford and IBH Publishing company, Bombay, Fourth Revised Edition, 1991.
4 McCormick, E.J., and M.S.Sanders, Human Factors in Engineering and Design, TMH, New Delhi, Seventh Edition, 1982.
5 Benjamin Neibal, W., Motion and Time Study, Seventh Edition, 1992.
6 Accident Prevention Manual for Industrial Operations, NSC Chicago, Fourth Edition, 1982.
7 Hunter, Gomas, Engineering Design for Safety, McGraw Hill Inc., New York, Second Edition, 1992.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20364	**DOCK SAFETY (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Determine the history of legislation towards dock safety.*	*Understand*
CO2:	*Recall about the cargo ships and the safety precautions in the use of transport equipment.*	*Understand*
CO3:	*Classify the different types of lifting appliances and its construction and maintenance.*	*. Understand*
CO4:	*Acquire knowledge on various types of transport equipment and their handling of cargos.*	*Understand*
CO5:	*Apply the emergency action plan for fire and explosions and understand about the dock regulations.*	*Apply*

UNIT - I HISTORY OF SAFETY LEGISLATION [09]

History of dock safety statues in India-background of present dock safety statues- dock workers (safety, health and welfare) act 1986 and the rules and regulations framed there under, other statues like marking of heavy packages act 1951 and the rules framed there under - manufacture, storage and import of hazardous chemicals. Rules 1989 framed under the environment (protection) act, 1989 - few cases laws to interpret the terms used in the dock safety statues.

Responsibility of different agencies for safety, health and welfare involved in dock work - responsibilities of port authorities - dock labour board - owner of ship master, agent of ship - owner of lifting appliances and loose gear etc. - employers of dock workers like stevedores - clearing and forwarding agents - competent persons and dock worker. Forums for promoting safety and health in ports - safe committees and advisory committees, their functions, training of dock workers.

UNIT - II WORKING ON BOARD THE SHIP [09]

Types of cargo ships - working on board ships - Safety in handling of hatch beams - hatch covers including its marking, mechanical operated hatch covers of different types and its safety features - safety in chipping and painting operations on board ships - safe means of accesses - safety in storage etc. - illumination of decks and in holds - hazards in working inside the hold of the ship and on decks - safety precautions needed - safety in use of transport equipment - internal combustible engines like fort-lift trucks - pay loaders etc. Working with electricity and electrical management - storages - types, hazardous cargo.

UNIT - III LIFTING APPLIANCES [09]

Different types of lifting appliances - construction, maintenance and use, various methods of rigging of derricks, safety in the use of container handling / lifting appliances like portainers, transtainer, top lift trucks and other containers - testing and examination of lifting appliances - portainers - transtainers - top lift trucks - derricks in different rigging etc. Use and care of synthetic and natural fiber ropes - wire rope chains, different types of slings and loose gears.

UNIT - IV TRANSPORT EQUIPMENT [09]

The different types of equipment for transporting containers and safety in their use safety in the use of self-loading container vehicles, container side lifter and fork lift truck, dock railways, conveyors and cranes. Safe use of special lift trucks inside containers - testing, examination and inspection of containers - carriage of dangerous goods in containers and maintenance and certification of containers for safe operation Handling of different types of cargo - stacking and un stacking both on board the ship and ashore - loading and unloading of cargo identification of berths/walking for transfer operation of specific chemical from ship to shore and vice versa - restriction of loading and unloading operations.

UNIT - V EMERGENCY ACTION PLAN AND DOCK WORKERS (SHW) REGULATIONS 1990 [09]

Emergency action Plans for fire and explosions - collapse of lifting appliances and buildings, sheds etc. - gas leakages and precautions concerning spillage of dangerous goods etc. - Preparation of on-site emergency plan and safety report. Dock workers (SHW) rules and regulations 1990 - related to lifting appliances, Container handling, loading and unloading, handling of hatch coverings and beams, cargo handling, conveyors, dock railways, forklift.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Bindra SR , Course in Dock and Harbour Engineering, Dhanpat Rai Publications (P) Ltd., New Delhi, 2013.

2 Srinivasan ,Harbour, Dock and Tunnel Engineering , Charotar Publishing House Pvt. Limited, New Delhi, 29th Edition, 2011.

3 International Labour Organization, Safety and Health in Dock Work, New York, second edition, 1997.

4 Safety and Health in Dock work, ILO, Third edition, 1992.

5 Indian Dock Labourers Act 1934 with rules 1948, Law Publishers (India) Pvt. Ltd., Allahabad, Second Edition, 1932.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20365	**SAFETY IN CONSTRUCTION (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to		***Cognitive Level***
CO1:	*Demonstrate about the accident causes and the management systems.*	*Understand*
CO2:	*Familiarize about the hazards in construction and their prevention.*	*Understand*
CO3:	*Analyze the safety procedure for working at heights during construction.*	*Analyze*
CO4:	*Apply knowledge selecting, operations, inspection and testing of various construction machinery.*	*Apply*
CO5:	*List out construction regulations and Indian standards for construction and demolition work.*	*Remember*

UNIT - I ACCIDENTS CAUSES AND MANAGEMENT SYSTEMS [9]

Problems impeding safety in construction industry - causes of fatal accidents, types and causes of accidents related to various construction activities, human factors associated with these accident - construction regulations, contractual clauses - Pre contract activates, preconstruction meeting - design aids for safe construction - permits to work - quality assurance in construction – compensation - recording of accidents and safety measures - education and training.

UNIT - II HAZARDS OF CONSTRUCTION AND PREVENTION [9]

Excavations, basement and wide excavation, trenches, shafts - scaffolding , types, causes of accidents, scaffold inspection checklist - false work - erection of structural frame work, dismantling - tunneling - blasting, pre blast and post blast inspection - confined spaces - working on contaminated sites - work over water - road works - power plant constructions - construction of high rise buildings.`

UNIT - III WORKING AT HEIGHTS [9]

Fall protection in construction OSHA 3146 - OSHA requirement for working at heights, Safe access and egress - safe use of ladders - Scaffoldings , requirement for safe work platforms, stairways, gangways and ramps - fall prevention and fall protection , safety belts, safety nets, fall arrestors, controlled access zones, safety monitoring systems - working on fragile roofs, work permit systems, height pass - accident case studies.

UNIT - IV SAFETY IN CONSTRUCTION MACHINERY [9]

Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - builder's hoist, winches, chain pulley blocks - use of conveyors - concrete mixers, concrete vibrators - safety in earth moving equipment, excavators, dozers, loaders, dumpers, motor grader, concrete pumps, welding machines, use of portable electrical tools, drills, grinding tools, manual handling scaffolding, hoisting cranes - use of conveyors and mobile cranes - manual handling.

UNIT - V SAFETY IN DEMOLITION WORK [9]

Safety in demolition work, manual, mechanical, using explosive - keys to safe demolition, pre survey inspection, method statement, site supervision, safe clearance zone, health hazards from demolition - Indian standard - trusses, girders and beams - first aid - fire hazards and preventing methods - interesting experiences at the construction site against the fire accidents.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Rita Yi Man Li, Sun Wah Poon, Construction Safety, Springer Heidelberg New York, Dordrecht London, First Edition, 2013.

2 Safety Handbook for the Building and Construction, Incolink (Australian construction association), Australia, First Edition, 2013.

3 Charles D. Reese and James V. Edison, Handbook of OSHA Construction safety and health, CRC press, UK, Second Edition, 2006.

4 Jnathea D.Sime, Safety in the Build Environment, London, Second Edition, 1988.

5 Davies, V.J., and Thomas, K., Construction Safety Hand Book, Thomas Telford Ltd., London, 1990.

6 Hudson, R., Construction hazard and Safety Hand book, Butter Worth's, New Delhi, Second Edition, 1985.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

IS20366 **TRANSPORT SAFETY** **(Elective)**

L	T	P	C
3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Acquire knowledge on causes of accidents due to drivers and pedestrians.*	*Understand*
CO2:	*Gain knowledge on inspection and maintenance of vehicles.*	*Understand*
CO3:	*Recall about the safety in road and rail transportation.*	*Understand*
CO4:	*Demonstrate about the safety in air transportation and shipping.*	*Understand*
CO5:	*Familiarize on shop floor and repair shop safety.*	*Understand*

UNIT - I OVERVIEW OF TRANSPORT SAFETY [9]

Introduction - factors for improving safety on roads - causes of accidents due to drivers and pedestrians - design, selection, operation and maintenance of motor trucks - preventive maintenance - check lists - motor vehicles act - motor vehicle insurance and surveys.

Driver safety programme - selection of drivers - driver training - tacho-graph - driving test - driver's responsibility - accident reporting and investigation procedures - fleet accident frequency - safe driving incentives - slogans in driver cabin - motor vehicle transport workers act - driver relaxation and rest pauses - speed and fuel conservation - emergency planning and Haz mat codes.

UNIT - II TRANSPORTATION OF HAZARDOUS GOODS [8]

Transport emergency card (TREM) - driver training - parking of tankers on the highways - speed of the vehicle - warning symbols - design of the tanker lorries - static electricity - responsibilities of driver - inspection and maintenance of vehicles - check list - loading and decanting procedures - communication.

UNIT - III SAFETY IN ROAD AND RAIL TRANSPORTATION [10]

Road alignment and gradient - reconnaissance - ruling gradient - maximum rise per k.m. - factors influencing alignment like attractive resistance, attractive force, direct alignment, vertical curves-breaking characteristics of vehicle - skidding - restriction of speeds - significance of speeds - pavement conditions - sight distance - safety at intersections - traffic control lines and guide posts - guard rails and barriers - street lighting and illumination overloading - concentration of driver.

Introduction to Rail Transportation - Rail Road Track - Materials and Cross section - Locomotives, Rail Car and Types - Rail road Worker Safety - Safety Performance, Gate Crossings and Trespassers - Signals and Communications, Types of rail road traffic control, other communication features - High Speed Rail Systems - Rail Road Construction and Maintenance methods, Construction and maintenance Equipment - Track Maintenance.

UNIT - IV SAFETY IN OTHER TRANSPORT SYSTEMS [9]

Introduction to Air Transportation - Trends in Air Transportation - Safety in Runway - Air Transportation System - Flight Maintenance, Construction and Safety - Storage and Handling of Fuels - Environmental Aspects of Air Transportation.

Types of cargo ships - working on board ships marking, safety in Shipping and painting operations on board ships - safe means of accesses - safety in storage etc - illumination of decks and in holds - hazards in working inside the hold of the ship and on decks - safety precautions needed.

UNIT - V SHOP FLOOR AND REPAIR SHOP SAFETY [9]

Transport precautions - safety on manual, mechanical handling equipment operations - safe driving - movement of cranes - conveyors etc., servicing and maintenance equipment - grease rack operation - wash rack operation - battery charging-gasoline handling - other safe practices - off the road motorized equipment.

Plant railway: Clearance - track - warning methods - loading and unloading - moving cars - safety practices.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Popkes, C.A. ,Traffic Control and Road Accident Prevention, Chapman and Hall Limited, New Delhi, Second Edition, 1986.

2 Babkov, V.F., Road Conditions and Traffic Safety, MIC Publications, Moscow, First Edition, 1986.

3 Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, Third Edition, 1983.

4 Motor Vehicles Act, 1988, Government of India.

5 Accident Prevention Manual for Industrial Operations, NSC, Chicago, Second Edition, 1982.

6 Pasricha,, Road Safety guide for drivers of heavy vehicle, Nasha Publications, Mumbai, Second Edition, 1999.

7 Ogden, K.W., Safer Roads – A guide to Road Safety Engineering.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20367	**FIREWORKS SAFETY (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Acquire knowledge on the properties of the chemicals used in the fireworks.*	*Understand*
CO2:	*Familiarize about the static charge and dust in fireworks factories.*	*Understand*
CO3:	*Recall about the various types of process in risk related fireworks.*	*Understand*
CO4:	*Analyze the material handling techniques and transportation of explosives in fireworks*	*Analyze*
CO5:	*Determine the concepts of waste control and user safety in fireworks*	*.Understand*

UNIT – I PROPERTIES OF FIREWORKS CHEMICALS [9]

Fire properties - potassium nitrate (KNO_3), potassium chlorate ($KClO_3$), barium nitrate ($BaNO_3$), calcium nitrate ($CaNO_3$), Sulphur (S), Phosphorous (P), Antimony (Sb), Pyro Aluminum (A1) powder - Reactions - metal powders, Borax, ammonia (NH_3) - Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.

UNIT – II STATIC CHARGE AND DUST [9]

Concept - prevention - earthling - copper plates - dress materials - static charge meter lightning, causes - effects - hazards in fireworks factories - lightning arrestor: concept - installation - earth pit – maintenance - resistance - legal requirements - case studies.

Dust: size - respirable, non-respirable - biological barriers - hazards - personal protective equipment - pollution prevention.

UNIT – III PROCESS SAFETY [8]

Safe - quantity, mixing - filling - fuse cutting - fuse fixing – finishing - drying at various stages – packing - storage - hand tools - materials, layout: building - distances - factories act - explosive act and rules - fire prevention and control - risk related fireworks industries.

UNIT – IV MATERIAL HANDLING [10]

Manual handling - wheel barrows - trucks - bullock carts - cycles - automobiles - fuse handling - paper caps handling -nitric acid handling in snake eggs manufacture - handling the mix in this factory - material movement - godown - waste pit.

Transportation: Packing - magazine - design of vehicles for explosive transports loading into automobiles - transport restrictions - case studies - overhead power lines - driver habits - intermediate parking - fire extinguishers - loose chemicals handling and transport.

UNIT – V WASTE CONTROL AND USER SAFETY [9]

Concepts of wastes - wastes in fireworks – disposal - spillages - storage of residues.

Consumer anxiety - hazards in display - methods in other countries - fires, burns and scalds - sales outlets - restrictions - role of fire service.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Morgan J. Hurley, Daniel T. Gottuk, John R. Hall Jr., SFPE Handbook of Fire Protection Engineering , First Edition, 2015.

2 John A. Purkiss, Long-Yuan Li , Fire Safety Engineering Design of Structures, CRC press, UK, Third Edition, 2013.

3 Proceedings of National seminar on Fireworks Safety - 1999, MSEC -1999.

4 Purkiss, J.A., Fireworks - Fire Safety Engineering,UK, Third Edition, 1996

5 Bill of Ofca, Fireworks Safety manual,1991

6 Ghosh, K.N., Principles of fireworks, Khatsuria, H., Sivakasi, Second Edition, 1987.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

IS20368 **SAFETY IN POWDER HANDLING (Elective)**

L	T	P	C
3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to

		Cognitive Level
CO1:	*Acquire knowledge on powder classification, its physical, chemical and other properties.*	*Understand*
CO2:	*Demonstrate about the metal powders and their characterization.*	*Understand*
CO3:	*Familiarize about Industrial dust and their explosion.*	*Understand*
CO4:	*Gain knowledge on dust handling plants and electro static hazards.*	*Understand*
CO5:	*Analyze about the dust evaluation methods and their control.*	*Analyze*

UNIT - I INTRODUCTION [8]

Powder classification - physical, chemical and other properties - metal powders - other non-metallic powders, Safety in cement, fly ash, quarry, sawdust, paint - handling methods - manual, mechanical, automatic - charges on powders -charge distribution - charging of powders.

UNIT - II METAL POWDERS AND CHARACTERIZATION [10]

Atomization, types - milling - electro deposition - spray drying, Production of iron powder, Aluminum powder, Titanium - screening & cleaning of metals - explosivity and pyrophoricity - toxicity.

Particle size and size distribution - measurement, types and significance - particle shape analysis, methods, surface area, density, porosity, flow rate - testing.

Metal powders, applications as fuel, solid propellants, explosives, pyrotechnics. Hazards in metal powder industries and safety principles.

UNIT - III DUST EXPLOSION [9]

Industrial dust, dust explosion accidents - explosibility characteristics, minimum explosive concentration, minimum ignition energy, explosion pressure characteristics, maximum permissible oxygen concentration - explosibility tests, Hartmann vertical tube apparatus, horizontal tube apparatus, inflammatory apparatus, Godbert and Green ward furnace. Explosibility classification - hybrid test - gas mixtures - dust ignition sources - dust explosion prevention - dust explosion protection - dust explosion venting, vent coefficient, various methods of design - venting of ducts and pipes - dust fire.

UNIT - IV DUST HANDLING PLANTS AND ELECTRO STATIC HAZARDS [9]

Grinding mills, conveyors, bucket elevators, dust separators, dust filters, cyclones, driers, spray driers, silos, grain elevators, typical applications, hazards and safety practices.

Electrostatic charges-energy released - type of discharge - spark - carona - insulating powders - propagating brush discharge - discharge in bulk lightning hazards in powder coating - electroplating.

UNIT - V DUST EVALUATION AND CONTROL [9]

Dust Evaluation, methodology, Quantitative, sampling, measurements - control approaches and strategies - control of dust sources, dust transmission - role of workers, PPE and work practice – housekeeping - storage - labeling - warning sign - restricted areas - Environmental protections.

Evaluation procedures and control measures for particulates (Respirable), Asbestos and other fibers, silica in coal mine - NIOSH guide to the selection and use of particulate respirators - case studies.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Martin Glor, Electro Static Hazard in Powder Handling, Research studies Press Ltd., England, Fourth Edition, 1988.

2 Major hazard control - ILO Geneva, 1987.

3 Seminar on Hazard recognition and prevention in the work place - airborne dust, Vol.I and 2, SRMC, Chennai, Second Edition, 4/5, Sept.2000.

4 ASM Metals hand book, Ninth edition, Vol.7, Powder Metallurgy.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20369	**NUCLEAR ENGINEERING AND SAFETY (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Explore the basic concepts of fission process and activity*	*. Understand*
CO2:	*Analyze the control requirements in design considerations*	*Analyze*
CO3:	*Classify the reactor types and their role of power generation in India.*	*Understand*
CO4:	*Apply the safe design principles of nuclear reactors and their safety*	*. Apply*
CO5:	*Acquire knowledge on radiation control, its exposure and their disposal practices.*	*Understand*

UNIT - I INTRODUCTION [9]

Binding energy - fission process - radio activity - alpha, beta and gamma rays radioactive decay - decay schemes - effects of radiation - neutron interaction - cross section - reaction rate - neutron moderation – multiplication – scattering - collision - fast fission - resonance escape - thermal utilization - criticality.

UNIT - II REACTOR CONTROL [9]

Control requirements in design considerations - means of control - control and shut down rods - their operation and operational problems - control rod worth - control instrumentation and monitoring - online central data processing system.

UNIT - III REACTOR TYPES [9]

Boiling water reactors - radioactivity of steam system - direct cycle and dual cycle power plants - pressurized water reactors and pressurized heavy water reactors - fast breeder reactors and their role in power generation in the Indian context - conversion and breeding - doubling time - liquid metal coolants - nuclear power plants in India.

UNIT - IV SAFETY OF NUCLEAR REACTORS [9]

Safety design principles - engineered safety features - site related factors - safety related systems - heat transport systems - reactor control and protection system - fire protection system - quality assurance in plant components - operational safety - safety regulation process - public awareness and emergency preparedness. Accident Case studies - Three Mile island and Chernobyl accident.

UNIT - V RADIATION CONTROL [9]

Radiation shielding - radiation dose - dose measurements - units of exposure - exposure limits - barriers for control of radioactivity release - control of radiation exposure to plant personnel - health physics surveillance - waste management and disposal practices - environmental releases.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Robert E. Masterson, Nuclear Engineering Fundamentals, CRC Press,UK,First Edition, 2017.

2 Jhon R. Lamarsh, Anthony J. Baratta ,Introduction to Nuclear Engineering , CRC Press , New York, Third Edition, 2014.

3 Dr. G. Vardyanathan., Nuclear reactor Engineering, UK, Second Edition, 2013.

4 Charles D. Ferguson, Nuclear Energy, New York, Second Edition, 2011.

5 Regulatory control of nuclear power plants Part A, International Atomic Energy Agency, Vienna, Austria, First Edition, 2002

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

IS20371 **SAFETY IN TEXTILE INDUSTRY (Elective)**

L	T	P	C
3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Familiarize about the basic concepts of textile process and its safety*	*. Understand*
CO2:	*Acquire knowledge on hazards in sizing processes, looms and knitting machines.*	*Understand*
CO3:	*Demonstrate on various types of mechanical finishing operations.*	*Understand*
CO4:	*Analyze about the health and welfare measures in textile industry.*	*Analyze*
CO5:	*Apply the relevant provisions of factories act and rules applicable to textile industry*	*.Apply*

UNIT – I INTRODUCTION [9]

Introduction to process flow charts of i) short staple spinning, ii) long staple spinning, iii) viscose rayon and synthetic fibre, manufacturer, iv) spun and filament yarn to fabric manufacture, v) jute spinning and jute fabric manufacture-accident hazard, guarding of machinery and safety precautions in opening, carding, combing, drawing, flyer frames and ring frames, doubles, rotor spinning, winding, warping, softening / spinning specific to jute.

UNIT – II TEXTILE HAZARDS - I [9]

Accident hazards i) sizing processes - cooking vessels, transports of size, hazards due to steam ii) Loom shed - shuttle looms and shuttles looms iii) knitting machines iv) non-woven's.

UNIT – III TEXTILE HAZARDS – II [9]

Scouring, bleaching, dyeing, punting, mechanical finishing operations and effluents in textile processes.

UNIT – IV HEALTH AND WELFARE [9]

Health hazards in textile industry related to dust fly and noise generation - control measures - relevant occupational diseases, personal protective equipment - health and welfare measures specific to textile industry, special precautions for specific hazardous work environments.

UNIT – V SAFETY STATUS [9]

Relevant provision of factories act and rules and other statues applicable to textile industry - effluent treatment and waste disposal in textile industry.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Safety in Textile Industry, Thane Belapur Industries Association, Mumbai, Second Edition, 1978.

2 100 Textile fibres - analysis, findings and recommendations LPA, 1989.

3 Groover and Henry, D.S., Hand book of textile testing and quality control, New Delhi, Ninth Edition, 1960.

4 Quality tolerances for water for textile industry, BIS, Second Revision, 1982.

5 Shenai, V.A., A technology of textile processing, Vol. I, Textile Fibers, Third Edition, 1972.

6 Little, A.H., Water supplies and the treatment and disposal of effluent.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

IS20372 **SAFETY IN MINES (Elective)**

L	T	P	C
3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Acquire knowledge on open cast mines and safe handling of explosives.*	*Understand*
CO2:	*Gain knowledge on underground mines and their working conditions.*	*Understand*
CO3:	*Demonstrate about the hazards and safety measures in tunneling.*	*Understand*
CO4:	*Analyze about the concept of risk assessment techniques*	*.Analyze*
CO5:	*Learn about accident analysis and its management systems.*	*Understand*

UNIT – I OPEN CAST MINES [9]

Causes and prevention of accident from: Heavy machinery, belt and bucket conveyors, drilling, hand tools - pneumatic systems, pumping, water, dust, electrical systems and fire prevention. Garage safety - accident reporting system - working condition - safe transportation - handling of explosives.

UNIT – II UNDERGROUND MINES [9]

Fall of roof and sides - effect of gases-fire and explosions - water flooding - warning sensors - gas detectors - occupational hazards - working conditions - winding and transportation.

UNIT – III TUNNELLING [9]

Hazards from: ground collapse, inundation and collapse of tunnel face, falls from platforms and danger from falling bodies. Atmospheric pollution (gases and dusts) - trapping - transport - noise - electrical hazards - noise and vibration from: pneumatic tools and other machines - ventilation and lighting - personal protective equipment.

UNIT – IV RISK ASSESSMENT [9]

Basic concepts of risk - reliability and hazard potential - elements of risk assessment - statistical methods - control charts - appraisal of advanced techniques - fault tree analysis - failure mode and effect analysis - quantitative structure - activity relationship analysis - fuzzy model for risk assessment.

UNIT – V ACCIDENT ANALYSIS AND MANAGEMENT [9]

Accidents classification and analysis - fatal, serious, minor and reportable accidents - safety audits - recent development of safety engineering approaches for mines - frequency rates - accident occurrence - investigation - measures for improving safety in mines - cost of accident - emergency preparedness - disaster management.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 D**h**illon, S Balbir*Mine., safety- A modern Approach,* Springer Publication, 2010.

2 Hartmann, *Introduction to mining engineering*, Wiley Publications, 2007.

3 Fred G. Bell, J. Laurance, *Mining and its impact on environment*, Taylor and Francis, 2006.

4 DGMS Circulars-Ministry of Labour, Government of India press, OR Lovely Prakashan-DHANBAD, 2002.

5 Kejiriwal, B.K., Safety in Mines, GyanPrakashan, Dhanbad, 2001.

6 Michael Karmis ed., Mine Health and Safety Management, SME, Littleton, Co.2001.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

IS20373	**PLANT LAYOUT AND MATERIALS HANDLING (Elective)**	L	T	P	C
		3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Acquire knowledge on plant locations and the safe storage of chemicals.*	*Understand*
CO2:	*Analyze the plant layout and their safety for various types of process industry.*	*Analyze*
CO3:	*Determine the principles of good ventilation and illumination*	*. Understand*
CO4:	*Gain knowledge on the benefits of an efficient material handling system and lifting tackles.*	*Understand*
CO5:	*Classify the various types of mechanical material handling devices.*	*Understand*

UNIT – I PLANT LOCATION [10]

Selection of plant locations, territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal, further expansions. Safe location of chemical storages, LPG, LNG, CNG, acetylene, ammonia, chlorine, explosives and propellants.

UNIT – II PLANT LAYOUT [10]

Safe layout, equipment layout, safety system, fire hydrant locations, fire service rooms, facilities for safe effluent disposal and treatment tanks, site considerations, approach roads, plant railway lines, security towers.

Safe layout for process industries, engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, metal powders manufacturing, fireworks and match works.

UNIT – III WORKING CONDITIONS [7]

Principles of good ventilation, purpose, physiological and comfort level types, local and exhaust ventilation, hood and duct design, air conditioning, ventilation standards, application.

Purpose of lighting, types, advantages of good illumination, glare and its effect, lighting requirements for various work, standards - Housekeeping, principles of 5S.

UNIT – IV MANUAL MATERIAL HANDLING AND LIFTING TACKLES [9]

Preventing common injuries, lifting by hand, team lifting and carrying, handling specific shape machines and other heavy objects - accessories for manual handling, hand tools, jacks, hand trucks, dollies and wheel barrows - storage of specific materials - problems with hazardous materials, liquids, solids – storage and handling of cryogenic liquids - shipping and receiving, stock picking, dock boards, machine and tools, steel strapping and sacking, glass and nails, pitch and glue, boxes and cartons and car loading - personal protection - ergonomic considerations.

Fiber rope, types, strength and working load inspection, rope in use, rope in storage - wire rope, construction, design factors, deterioration causes, sheaves and drums, lubrication, overloading, rope fitting, inspection and replacement – slings, types, method of attachment, rated capacities, alloy chain slings, hooks and attachment, inspection.

UNIT – V MECHANICAL MATERIAL HANDLING [9]

Hoisting apparatus, types - cranes, types, design and construction, guards and limit devices, signals, operating rules, maintenance safety rules, inspection and inspection checklist - conveyors, precautions, types, applications.

Powered industrial trucks, requirements, operating principles, operators selection and training and performance test, inspection and maintenance, electric trucks, gasoline operated trucks, LPG trucks – power elevators, types of drives, hoist way and machine room emergency procedure, requirements for the handicapped, types- Escalator, safety devices and brakes, moving walks - man lifts, construction, brakes, inspection.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1. C. Ray Asfahl, David W. Rieske., Industrial Safety and Health Management , Prentice Hall, U.K., seventh edition, 2018.
2. Encyclopedia of occupational safety and health, ILO Publication, Francis, Fourth Edition, 1998
3. Apple M. James., Plant layout and material handling, John Wiley & sons, New York, Third edition, 1977
4. Reymond, A.Kulwice., Material Handling Hand Book - II, John Wiley and Sons, New York, 1985.
5. Safety and good housekeeping, N.P.C. New Delhi, 1985.
6. Industrial ventilation (A manual for recommended practice), American conference of government industrial Hygiene, Thirty Edition, USA, 1984.
7. Accident prevention manual for industrial operations, N.S.C., Fourth Edition, Chicago, 1982.
8. Rudenko, N., Material handling Equipments, Mir Publishers, Fifth Edition, 1981.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

IS20374 **DISASTER MANAGEMENT (Elective)**

L	T	P	C
3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to

		Cognitive Level
CO1:	*Recall about the concepts of disaster management and meteorological phenomena.*	*Understand*
CO2:	*Familiarize about the technological disasters and its case study.*	*Understand*
CO3:	*Acquire knowledge on environmental pollution and its impact assessment.*	*Understand*
CO4:	*Apply the concepts of marine pollution and its control with global environmental issues.*	*Apply*
CO5:	*Analyze environmental education with risk assessment process for different disaster types.*	*Analyze*

UNIT – I INTRODUCTION [9]

Philosophy of disaster management - Introduction to disaster mitigation - hydrological, coastal and marine disasters - atmospheric disasters - geological, meteorological phenomena - mass movement and land disasters - forest related disasters - wind and water related disasters - deforestation - use of space technology for control of geological disasters - Master thesis.

UNIT – II TECHNOLOGICAL DISASTERS [9]

Technological Disasters - Case studies of Technology disasters with statistical details Emergencies and control measures - APELL - Onsite and Offsite emergencies - Crisis management groups - Emergency centers and their functions throughout the country - Software's on emergency controls - Monitoring devices for detection of gases in the atmosphere - Right to know act.

UNIT – III ENVIRONMENTAL POLLUTION [9]

Introduction to sustainable development – Bio - diversity - atmospheric pollution - global warming and Ozone Depletion - ODS banking and phasing out - sea level rise - El Nino and climate changes - eco friendly products - green movements - green philosophy - environmental policies - Environmental Impact Assessment - case studies - Life cycle.

UNIT – IV MARINE POLLUTION [9]

Offshore and onshore drilling - control of fires - Case studies - Marine pollution and control - Toxic, hazardous and Nuclear wastes - state of India's and Global environmental issues carcinogens - complex emergencies - Earthquake disasters - the nature - extreme event analysis - the immune system - proof and limits.

UNIT – V ENVIRONMENTAL EDUCATION [9]

Environmental education - population and community ecology - natural resources conservation - environmental protection and law - Research methodology and systems analysis - Policy initiatives and future prospects - Risk assessment process, assessment for different disaster - types - assessment data use, destructive capacity - risk adjustment - choice - loss acceptance - disaster aid - public liability insurance - stock taking and vulnerability analysis - disaster profile of the country - national policies - objectives and standards - physical event modification - preparedness, forecasting and warning, land use planning.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 R. Subramanian ,Disaster Management, Vikas Publishing House, Second Edition ,2018.

2 Miller, G., Taylor, Environmental Science, Cengage Learning Publisher sustaining the Earth, 2015, Cengage Learning Publisher,Fifth Edition,U.K., 2014.

3 Gilbert, M. Masters, Introduction to Environmental Engineering and Science, Pearson New International Edition, Wendell P. Ela · 2013.

4 Bagad Vilas, Principles of Environmental Science and Engineering, Technical Publication, Fourth Edition, 2012.

5 Sivakumar R., Principles of Environmental Science and Engineering, Vijay Nicole Imprints, Second Edition, 2005.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

IS20375 **OHSAS18000 AND ISO14000 (Elective)**

L	T	P	C
3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Acquire knowledge on the basic concepts of OSHA standard*	*. Understand*
CO2:	*Explore the details of OHSAS 18000 policy and planning with their guidelines and methods.*	*Understand*
CO3:	*Apply the concepts of implementation, review and improvement plan.*	*Apply*
CO4:	*Analyze about ISO 14000 and 45001 policies with its planning.*	*Analyze*
CO5:	*Acquire knowledge on environmental impact assessment, types & control.*	*Understand*

UNIT - I OHSAS STANDARD [9]

Introduction - development of OHSAS standard - Structure and features of OSHAS 18001 - benefits of certification-certification procedure - OH & S management system element, specification and scope - correspondence between OHSAS 18001, ISO 14001:1996 and ISO 9001:1994 – guidelines (18002:2000) for implementing OHSAS 18001.

UNIT - II OHSAS 18000 POLICY & PLANNING [9]

Developing OH & S policy – guidelines - developments - procedure - content of OH & S policy – General principle, strategy and planning, specific goals, compliance - methodology.

Planning - guidelines, methodology steps developing action plan - analysis and identification of priorities, objective & targets, short term action plan, benefits and cost of each option, Development of action plan.

UNIT - III IMPLEMENTATION, REVIEW AND IMPROVEMENT PLAN [9]

Guidelines for structure and Responsibilities, Top level management, middle level management, co-ordinator and employees - developing procedures, identifying training needs, providing training, documentation of training, Training methodology consultation and communications.

Checking & Review; performance measurement and monitoring, proactive and reactive monitoring, measurement techniques, inspections, measuring equipment - accidents reports, Process & procedures, recording, investigation corrective action and follow up - records and records management. Handling documentation, information, records.

UNIT - IV ISO 14000 POLICY, ISO 45001 POLICY & PLANNING [9]

EMS, ISO 14001, specifications, objectives, Environmental Policy, Guidelines & Principles (ISO 14004), clauses 4.1 to 4.5. Documentation requirements, 3 levels of documentation for an ISO 14000 based EMS, steps in ISO 14001.

Implementation plan, Registration, importance of ISO 14000 to the Management. Auditing ISO14000-General principles of Environmental Audit, Auditor, steps in audit, Audit plan.

ISO 45001 – Scope, Terms and definitions,OH&S Policy, Planning, Objectives, Documentation, Importance, Evaluation, Management Review.

UNIT - V ENVIRONMENT IMPACT ASSESSMENT [9]

ISO 14040 (LCA), General principles of LCA, Stages of LCA, Report and Review. ISO 14020 (Eco labeling) - history, 14021, 14024, Type I labels, Type II labels, ISO 14024, principles, rules for eco labeling before company attempts for it, advantages, EIA in EMS, types of EIA, EIA methodology - EIS, Scope, Benefits. Audit - methodology, auditors audit results, management review - Continual improvement.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria& Sons, Delhi, First Edition, 2003.

2 NQA-ISO-45001-Implementation-Guide.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20376	**LOW TEMPERATURE COMBUSTION (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Analyze the physical and chemical properties of combustion.*	*Analyze*
CO2:	*Recognize the conventional and alternate combustion technologies, their merits and demerits.*	*Understand*
CO3:	*Implement the Low temperature combustion technology to the existing gasoline and diesel engines.*	*Understand*
CO4:	*Identify the various HCCI combustion control techniques and their implementation in safety aspects.*	*Understand*
CO5:	*Analyze the requirements of the fuel to adopt Low temperature combustion technology in the IC engines.*	*Analyze*

UNIT – I PHYSICS AND CHEMISTRY OF FIRE [9]

Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - theory of combustion and explosion – vapour clouds – flash fire – jet fires – pool fires – unconfined vapour cloud explosion, shock waves - auto-ignition – boiling liquid expanding vapour explosion – case studies –Bombay Victoria dock ship explosions, Mahul refinery explosion and Vizag refinery disaster.

UNIT – II HCCI ENGINE FUNDAMENTALS [9]

Introduction, HCCI, RCCI, PCCI Fundamentals - background of HCCI, Principle, Benefits, Challenges, Need for control.

UNIT – III GASOLINE AND DIESEL HCCI COMBUSTION ENGINES [9]

Conventional Gasoline Combustion, Effects of EGR, Techniques to HCCI operation in gasoline engines, Conventional Diesel Combustion, Overview of diesel HCCI engines, Techniques–Early Injection, Multiple injections, Narrow angle direct injection (NADI™) concept.

UNIT – IV HCCI CONTROL TEHNIQUES IN SAFETY ASPECTS [9]

Control Methods, Combustion timing sensors, HCCI/SI switching, Transition between operating modes (HCCI-SI-HCCI), Fuel effects in HCCI - gasoline, diesel, auto – ignition requirement, combustion phasing, Influence of equivalence ratio, auto - ignition timing, combustion duration, auto - ignition temperature and auto - ignition pressure, Combustion limits, IMEP and indicated efficiency- Trends in characterizing fuel performance in HCCI engines.

UNIT – V HCCI FUEL REQUIREMENTS & COMBUSTION WITH ALTERNATIVE FUELS [9]

Introduction, Background, Diesel fuel HCCI, HCCI fuel ignition quality, Gasoline HCCI, HCCI fuel Specification, Fundamental fuel factors. Natural gas HCCI engines, CNG HCCI engines, methane/n-butane/air mixtures. DME HCCI engine-chemical reaction model, Combustion completeness, Combustion control system, Method of combining DME and other fuels, 'unmixed-ness' of DME/air mixture.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Alexandros G. Charalambides ,Homogenous Charge Compression Ignition (HCCI) Engines. In HoonKiat Ng ,Advances in Internal Combustion Engines and Fuel Technologies(pp. 119-148), In Tech publications, New Delhi, Second Edition, 2013.

2 B.P. Pundir, Engine Combustion and Emission, Narosa Publishing House, New Delhi, First Edition, 2011

3 Hua Zhao., HCCI and CAI Engines for automotive industry, Wood Head Publishing in Mechanical Engineering, UK, Second Edition, 2007.

4 Fuquan Zhao, Thomas W Asmus, Dennis N. Assanis, Paul M Najt., Homogeneous Charge Compression Ignition (HCCI) Engines: Key Research and Development Issues, SAE Internationals, New Delhi, First Edition, 2003.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20377	**BIO FUELS IN IC ENGINES (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to		***Cognitive Level***
CO1:	*Apply the bio resources that can be used for the production of bio fuels*	*.Apply*
CO2:	*Identify the properties of vegetable oils and various process of making bio fuels from vegetable oils*	*. Understand*
CO3:	*Evaluate the physical and chemical properties of the biodiesel*	*. Evaluate*
CO4:	*Analyze the safety features in bio fuels to implement it in an Engine.*	*Analyze*
CO5:	*Determine the emission and performance characteristics of bio fuels*	*. Understand*

UNIT – I INTRODUCTION [8]

Energy and Environment Overview – Energy scenario in India – Importance of biodiesel in India - Sources of Biodiesel - Biodiesel standards - Emission standards.

UNIT– II VEGETABLE OILS [8]

Availability of vegetable oils -Non-edible oils as biodiesel - Scenario of non-edible oils in India - Blending, Emulsification, Pre heating and – Transesterification.

UNIT– III PHYSICAL, CHEMICAL AND THERMAL PROPERTIES [10]

Effect of vegetable oil chemical structure on biodiesel properties - Methodology for various properties estimation - Physical and chemical properties of Biodiesel-Effect of specific heat on biodiesel combustion and performance - Role of latent heat of vaporization in biodiesel combustion process - Effect of thermal conductivity and thermal diffusivity on performance of D.I. diesel engine.

UNIT – IV SAFETY ASPECTS IN BIO FUELS [8]

Fire and Explosion Hazards of Bio fuels - Chemical Reactivity Hazards in Bio fuel Manufacturing - Toxicity Hazards in Biofuels Manufacturing–Measures to increase the safety - Comparison of bio fuels and conventional fuels.

UNIT–V EMISSION CHARECTERISTICS OF BIODIESEL [11]

Performance of fuel pump, filter, injection, piston head, Piston rings, and lub oil - Performance parameters of Biodiesel as well as blends - Combustion characteristics of Biodiesel (ignition delay, maximum pressure, combustion duration, maximum temperature, heat release rate and mass burning rate) and blends - Emission characteristics of Biodiesel and blends.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 OzcanKonur, Biodiesel Fuels: Science, Technology, Health, and Environment, CRC press, 2021.

2 V Ganesan., Internal Combustion Engines, McGraw Hill Education , Fourth edition, 2017.

3 Eiri Board., Technology of Bio-Fuels (Ethanol & Biodiesel), Engineers India Research Institute, 2010.

4 Biodiesel Handling and use Guidelines, 2004.

5 Tickell, Joshua, Tickell, Kaia., From the Fryer to the Fuel Tank, The Complete Guide to using vegetable oils as an alternative Fuel, Second Edition 1999.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20378	**REFRIGERATION AND CRYOGENIC ENGINEERING (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Analyze the various cycles of refrigeration.*	*Analyze*
CO2:	*Design the refrigeration system components.*	*Understand*
CO3:	*Analyze the principle of liquefaction.*	*Analyze*
CO4:	*Choose the suitable method of gas liquefaction.*	*Understand*
CO5:	*Select the required storage method for the cryogenic liquids.*	*Understand*

UNIT – I ANALYSIS OF REFRIGERATION CYCLES [9]

Development of vapour compression refrigeration cycle from reverse Carnot cycle- conditions for high COP-deviations from ideal vapour compression cycle, multi pressure system, cascade systems-analysis. Vapour absorption systems-aqua ammonia & Li-Br systems, air refrigeration cycles, heat pumps.

UNIT – II REFRIGERATION SYSTEM COMPONENTS [9]

Compressors- types, performance, characteristics, types of evaporators & condensers and their functional aspects, expansion devices and their behavior with fluctuating load, cycling controls, other components such as accumulators, receivers, oil separators, strainers, driers, check valves, solenoid valves, defrost controllers, etc.

UNIT – III PRINCIPLES OF LIQUEFACTION [9]

Joule thomson effect and inversion curve; adiabatic and isenthalpic expansion with their comparison. Properties of cryogenic fluids; properties of solids at cryogenic temperatures; Superconductivity.

UNIT – IV GAS LIQUEFACTION SYSTEMS [9]

Recuperative Linde Hampson, Claude, cascade, Heylandt, Kapitza, Collins; regenerative stirling cycle and refrigerator, Slovay refrigerator, Gifford-mcmahon refrigerator, vuilleumier refrigerator, pulse tube refrigerator; liquefaction of natural gas.

UNIT – V STORAGE OF CRYOGENIC LIQUIDS [9]

Design considerations of storage vessel; dewar vessels; industrial storage vessels; storage of cryogenic fluids in space; transfer systems and lines for cryogenic liquids; cryogenic valves in transfer lines; two phase flow in transfer system; cool-down of storage and transfer systems

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 CP Arora., Refrigeration and air conditioning, McGraW Hill., Fourth edition, 2020.

2 P.N. Ananthanarayanan, “Basic Refrigeration and Air Conditioning”’ Fourth Edition, Tata McGraw-Hill Education Pvt. Ltd, 2015.

3 MamataMukhopadhyay., Fundamentals of Cryogenic Engineering ,PHI, 2010.

4 R S Khurmi.,J K Gupta., Refrigeration and Air Conditioning, S Chand publications, 2006.

5 CB Smith, Energy Management Principles, Pergamon Press, New York, 1995.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20379	**ENERGY CONSERVATION AND MANAGEMENT (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Describe the present energy scenario of India and standards and EC act.*	*Understand*
CO2:	*Analyze and optimize the energy requirement and identify the suitable system for energy management*	*. Analyze*
CO3:	*Analyze the cost vs. energy and identify suitable technique for cost analysis.*	*Analyze*
CO4:	*Analysis of operation and energy conservation*	*Analyze*
CO5:	*Study of thermal utilities.*	*Understand*

UNIT – I INTRODUCTION [9]

Indian Energy Scenario Basics of Energy and its various forms - Primary / Secondary Energy Sources Energy Conservation Energy Intensive Industries Barriers - EC Act 2003: Salient Features - Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies - Integrated energy policy - National action plan on climate change.

UNIT – II ENERGY MANAGEMENT [9]

Energy management approach - understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy metering, precautions, smart metering.

UNIT – III ENERGY ECONOMICS [9]

Roles and responsibilities of energy manager, accountability. energy consumption, production, cumulative sum of differences (CUSUM) Cost / Energy Share Diagram Break Even Analysis Depreciation Financial Analysis Techniques CUSUM Technique Energy Management Information Systems (EMIS) ESCO Concept

UNIT – IV THERMAL UTILITIES: OPERATION AND ENERGY CONSERVARTION [9]

i) Boilers (ii) Thermic Fluid Heaters (iii) Furnaces (iv) Waste Heat Recovery Systems (v) Thermal Storage

UNIT – V PERFORMANCE STUDY OF THERMAL UTILITIES [9]

Basics of R & A/C COP / EER / SEC Evaluation Psychometric Chart Analysis Types & Applications of Cooling Towers Basics Performance Analysis - Cost of Power Generation Scope for Energy Thermal systems

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 K.V.Sharma, P.Venkataseshaiah., Energy Management and Conservation, Wiley, New Delhi, First Edition, 2020.

2 Frank Kreith, D. Yogi Goswami, Energy Management and Conservation, CRC press, UK, Second Edition, 2016.

3 S.S. Thipse, Energy Conservation and Management, Alpha Science, New Delhi, First Edition, 2014.

4 Barun Kumar De., Energy Management, Vrinda Publications ,UK, Second Revised, 2014.

5 Trivedi , PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi, Fourth Edition, 2000.

6 Witte, Larry C, Industrial Energy Management & Utilization, Hemisphere Publishers, Washington, Seventh Edition, 2000.

7 CB Smith, Energy Management Principles, Pergamon Press, New York, Second Edition, 1995.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20380	**REFRIGERATION AND AIR CONDITIONING (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Perform basic calculations related to various refrigeration cycles and air conditioning processes.*	*Understand*
CO2:	*Differentiate between various types of refrigeration systems.*	*Understand*
CO3:	*Apply psychrometry principles.*	*Apply*
CO4:	*Analyze thermodynamic processes occurring inside compressors, condensers and expansion devices used in refrigeration systems.*	*Analyze*
CO5:	*Analyzes of air conditioning systems.*	*Analyze*

UNIT - I AIR CYCLE REFRIGERATION [9]

Review of thermodynamic principles of refrigeration. Bell Coleman air refrigeration - Aircraft cycle - simple, boot strap and regenerative cycle analysis - COP calculation

UNIT - II REFRIGERANT SELECTION [9]

Properties, Eco - friendly refrigerants, Selection of Refrigerants.

UNIT - III VAPOUR COMPRESSION AND VAPOUR ABSORPTION REFRIGERATION SYSTEMS [9]

T-S and P-H charts - analysis - Performance of systems under varying operating conditions. Multi-stage refrigeration working principles. Ammonia - water systems, three fluid systems. Water - lithium bromide system - Comparison - Steam jet refrigeration, solar refrigeration

UNIT - IV BALANCING OF COMPONENTS [9]

Condensers - Air cooled, water cooled and evaporative condensers. Evaporator - flooded, dry expansion, shell and tube and double pipe. Compressors - reciprocating, rotary and centrifugal types. Expansion devices - capillary and TEV.

UNIT - V AIR CONDITIONING SYSTEMS [9]

Psychrometric processes - use of psychrometric chart - Bypass factor - air conditioning cycles - winter, summer and year round air conditioning systems - effective temperature - comfort conditions. Duct design (theoretical treatment) -economic considerations, methods - air distributing systems - humidification - air cleaning - controls - window air conditioners.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Arora C.P., Refrigeration and Air Conditioning, Tata McGraw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2020.

2 P.N. Ananthanarayanan., Basic Refrigeration and Air Conditioning, Tata McGraw-Hill Education Pvt. Ltd, New Delhi, Fourth Edition, 2015.

3 R S Khurmi, J K Gupta., Refrigeration and Air Conditioning, S Chand publications, New Delhi, Second Edition, 2006.

4 Stoecker W.F. and Jones J.W., Refrigeration & Air Conditioning, McGraw Hill Book Company, New York, Second Edition, 1985.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20381	**FOOD PROCESSING, PRESERVATION AND TRANSPORT (Elective)**	3	0	0	3

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	Recall the methods of food processing.	*Understand*
CO2:	Analysis of food processing and preservation methods.	Analyze
CO3:	Analyze the freezing and drying processes.	Analyze
CO4:	*Design the* cold storage and instrumentation.	*Understand*
CO5:	Analysis of packing and transporting the food products.	Analyze

UNIT - I INTRODUCTION [9]

Microbiology of Food Products, Mechanism of food spoilage critical microbial growth requirements, Design for control of micro organisms, The role of HACCP, Sanitation, Regulation and standards.

UNIT - II PROCESSING & PRESERVATION [9]

Thermodynamic properties and Transfer properties, Water content, Initial freezing temperature, Ice fraction, Transpiration of fresh fruits & vegetables, Food processing techniques for Dairy products, Poultry, Meat, Fruits & Vegetables.

UNIT - III FREEZING & DRYING [9]

Precooling, Freeze drying principles, Cold storage & freezers, Freezing drying limitations, Irradiation techniques, Cryofreezing, Numerical and analytical methods in estimating Freezing, Thawing times, Energy conservation in food industry.

UNIT - IV COLD STORAGE DESIGN & INSTRUMENTATION [9]

Initial building consideration, Building design, Specialized storage facility, Construction methods, Refrigeration systems, Insulation techniques, Control & instrumentation, Fire protection, Inspection & maintenance

UNIT - V PACKAGING AND TRANSPORT [9]

Refrigerated transportation, Refrigerated containers & trucks, Design features, Piping & Role of cryogenics in freezing & transport. Basic packaging materials, types of packaging, Packaging design. Packaging for different types of foods.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 DS Warris., Food Processing and Preservation, CBS, New York, Second Edition, 2020.

2 Srivastava., Fruit and Vegetable Preservation, CBS, New York, Third Edition, 2019.

3 G. Subbulakshmi., Food Processing and Preservation, New Age Publishers, New Delhi, Second Edition, 2006.

4 IbrahamDincer., Heat Transfer in Food Cooling Applications, Tailor & Francis Pub., UK, Fourth Edition, 1997.

5 Clive V.I. Dellino, Cold and Chilled Storage Technology, VanNostrand Reinhold Pub. New York, Second Edition, 1991.

6 Stanley E. Charm, Fundamentals of Food Engineering,AVI Pub. Company Inc., New Delhi, Third Edition, 1989.

7 Alan Rodes, Principles of Industrial Microbiology, Pregmon International Pub., New York, Fifth Edition, 1989.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

IS20382 **RESEARCH METHODOLOGY AND IPR (Elective)**

L	T	P	C
3	0	0	3

Course Outcomes : **Upon Completion of the course, the students should be able to** ***Cognitive Level***

CO1:	*Examine research problem formulation.*	*Understand*
CO2:	*Analyze research related information*	*Analyze*
CO3:	*Follow research ethics.*	*Understand*
CO4:	*Utilize the* Patent information and databases	*Apply*
CO5:	*Emphasis the need of information about Intellectual Property Right to be promoted among students in general and engineering in particular.*	*Understand*

UNIT – I BASCIS OF RESEARCH PROBLEM [9]

Meaning of research problem – Sources of research problem – Criteria Characteristics of a good research problem – Errors in selecting a research problem – Scope and objectives of research problem. Approaches of investigation of solutions for research problem – Data collection – Analysis – Interpretation – Necessary instrumentations.

UNIT – II TECHNICAL WRITING AND PROPOSAL [9]

Effective literature studies approaches – Analysis Plagiarism – Research ethics – Effective technical writing – How to write Report – Paper – Developing Research Proposal – Format of research proposal – Presentation and Assessment by a review committee.

UNIT – III INTELLECTUAL PROPERTY [9]

Nature of Intellectual Property: Patents – Designs –Trade and Copyright. Process of Patenting and Development: Technological research – Innovation – Patenting – Development. International Scenario: International cooperation on Intellectual Property – Procedure for grants of patents – Patenting under PCT.

UNIT – IV PATENT RIGHTS [9]

Patent Rights: Scope of Patent Rights – Licensing and transfer of technology – Patent information and databases – Geographical Indications.

UNIT – V DEVELOPMENTS IN IPR [9]

New Developments in IPR: Administration of Patent System – New developments in IPR – IPR of Biological Systems – Computer Software – Traditional knowledge Case Studies – IPR and IITs.

Total = 45 Periods

Reference Books :

1 Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Juta and Company Ltd, Lansdowne, Second Edition, 2004.

2 Ranjit Kumar, Research Methodology: A Step by Step Guide for beginners, SAGE Publications Asia-Pacific Pvt Ltd, Singapore, Third Edition, 2014.

3 Stuart Melville and Wayne Goddard, Research methodology: an introduction for science & engineering students, Juta & Co , Kenwyn, South Africa, Second Edition,1996.

4 Halbert, Resisting Intellectual Property, Taylor & Francis Ltd, London, First Edition, 2007.

5 Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age, Aspen Publishers, New York, Sixth Edition 2016.

6 T. Ramappa, Intellectual Property Rights Under WTO, S. Chand, Wheeler Publishing, Hyderabad, Second Edition, 2008

7 Stuart Melville and Wayne Goddard, Research methodology: an introduction for science & engineering students, Lansdowne ,Juta and Company Ltd, First Edition, 1996.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20383	**ADVANCED MATERIALS (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Comprehend the construction of composite materials*	*.Understand*
CO2:	*Develop the production process of polymer matrix composites.*	*Analyze*
CO3:	*Acquire to build the different manufacturing methods.*	*Understand*
CO4:	*Explore the shape memory alloys and applications.*	*Understand*
CO5:	Discover the nano materials and applications.	*Analyze*

UNIT – I INTRODUCTION [09]

INTRODUCTION TO COMPOSITE MATERIALS: Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiber reinforced composites and nature-made composites, and applications.

REINFORCEMENTS: Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and born carbide fibres.

UNIT – II POLYMER MATRIX COMPOSITE [09]

Polymer composites, thermoplastics, thermosetting plastics, manufacturing of PMC, MMC & CCC and their applications.

UNIT – III MANUFACTURING METHODS [09]

Autoclave, tape production, moulding methods, filament winding, hand layup, pultrusion, RTM.

UNIT – IV SHAPE MEMORY ALLOYS [09]

FUNCTIONALLY GRADED MATERIALS: Types of functionally graded materials-classification different systems-preparation-properties and applications of functionally graded materials.

SHAPE MEMORY ALLOYS: Introduction-shape memory effect-classification of shape memory alloys composition-properties and applications of shape memory alloys.

UNIT – V NANO MATERIALS [09]

Introduction-properties at nano scales-advantages & disadvantages-applications in comparison with bulk materials (nano – structure, wires, tubes, composites). State of art nano advanced- topic delivered by student.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Mechanics of Composite Materials / R. M. Jones/ Mc Graw Hill Company, New York, 1975.

2 Analysis of Laminated Composite Structures / L. R. Calcote/Van Nostrand Rainfold,NY 1969

3 Analysis and performance of fibre Composites /B. D. Agarwal and L. J. Broutman /Wiley-Interscience, New York, 1980

4 Mechanics of Composite Materials – Second Edition (Mechanical Engineering) /Autar K.Kaw / CRC Press

5 Nano material /A.K. Bandyopadyay, New age Publishers.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20384	**WELDING ECONOMICS, MANAGEMENT AND SAFETY (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	Gain knowledge on various factors influencing the welding cost.	*Understand*
CO2:	Estimate the standard welding time using various methods for the welding processes.	*Analyze*
CO3:	Calculate the welding cost for the different welding process.	*Apply*
CO4:	Gain knowledge on various requirements on setting up a welding plant layout.	*Understand*
CO5:	Gain knowledge on safety measures during welding processes and planning operations.	*Understand*

UNIT – I FACTORS INFLUENCING WELDING ECONOMICS [09]

Welding design- selection of electrodes, size, type and metal recovery – electrode efficiency, sub, thrown away electrodes – over welding and joint fit – up welding position - operation factor – jigs, fixtures, positioners, Operator efficiency.

UNIT – II ESTIMATION OF WELDING TIME [09]

Need for time standard – definition of standard time- various methods of computing standard time – analytical calculation – computerisation of time standards

UNIT – III ESTIMATION ANDCOSTING FOR WELDING [09]

Definition of terms – composition of welding costs, cost of consumables – labour cost – cost over heads - formulae for total cost – cost curves for different processes like GMAW, SAW, ESW, Mechanization in welding – job shop operation.

UNIT – IV PROCESS AND PLANT LAY OUT [09]

Process vs product lay out – construction – service consideration – employees- services, welding shop equipment, oxy acetylene stations- resistance welding stations – inert gas welding stations – arc welding stations – crane forges - jigs and fixtures; power tools - blast cleaning supplies- welding equipment repair shop - proper arrangement of the above in the welding shop for maximum convenience and ease of production.

UNIT – V SAFE PRACTICES IN WELDING [09]

Selection and installation of equipments, safe handling equipment - fire prevention- eye and face protection - respiratory protection - ventilation -protective extra clothing -electric shock- safety analysis.

Planning for welding operations, production control planning for welding processes- pre- production planning- routing - scheduling. Activating, monitoring, materials management in welding-Inventory control- Basic aspects of financial management and man-power planning.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 ASM Metals Handbook, Vol.6, “Welding, Brazing and Soldering”, ASM, New York, 1998.

2 AWS Welding Handbook, vol.5, “Engineering Costs, Quality and Safety”, 9th edition, AWS,2015.

3 John Norrish, “Arc Welding Processes - Technologies and process control”, Woodhead Publishing and Maney Publishing on behalf of The Institute of Materials, Minerals & Mining, 2006.

4 standard Data for Arc Welding – The Welding Institute, U.K., 1994.

5 Bathy. J., “Industrial Administration and Management”, 1984.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20385	**COMPOSITE MATERIALS AND MECHANICS (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Infer the basic concepts and characteristics of composites*	*.Understand*
CO2:	*Explore the micromechanics of composite materials.*	*Understand*
CO3:	*Apply the stress and strain, Elastic behavior of composite materials.*	*Apply*
CO4:	*Develop the strength of unidirectional lamina.*	*Understand*
CO5:	Analyze the laminated composite plates.	*Analyze*

UNIT – I BASIC CONCEPTS AND CHARACTERISTICS [09]

Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites.

Reinforcements: Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.

UNIT – II MICROMECHANICS [09]

Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties.

Manufacturing methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion,RTM.

UNIT – III COORDINATE TRANSFORMATION [09]

Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off – axis, stiffness modulus, off – axis compliance.

Elastic behavior of unidirectional composites: Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

UNIT – IV STRENGTH OF UNIDIRECTIONAL LAMINA [09]

Micro mechanics of failure, Failure mechanisms, strength of an orthotropic lamina, strength of a lamina under tension and shear maximum stress and strain criteria, application to design. The failure envelope, first ply failure, free-edge effects. Micros mechanical predictions of elastic constants.

UNIT – V ANALYSIS OF LAMINATED COMPOSITE PLATES [09]

Introduction thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.

2 Analysis and performance of fibre Composites/ B. D. Agarwal and L. J. Broutman/ Wiley-Interscience, New York, 1980.

3 Mechanics of Composite Materials/ Second Edition (Mechanical Engineering)/ Autar K. Kaw ,CRC,1996

4 Analysis of Laminated Composite Structures/ L. R. Calcote/ Van Nostrand Rainfold, New York, 1969.

5 Mechanics of Composite Materials/ R. M. Jones/ Mc Graw Hill Company, New York, 1975.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20386	**ADDITIVE MANUFACTURING (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	Apply the concepts of rapid prototyping in product design and development	*Apply*
CO2:	Select the suitable liquid based rapid prototyping system for a specific application .	*Apply*
CO3:	Select the suitable solid based rapid prototyping system for a specific application .	*Apply*
CO4:	Select the suitable powder based rapid prototyping system for a specific application	*Apply*
CO5:	Apply the concepts of rapid prototyping in product design and development.	*Apply*

UNIT – I Introduction to Additive Manufacturing [09]

Introduction to Additive Manufacturing: Evolution, fundamental fabrication processes, CAD for RPT, product design and rapid product development - Need for time compression in product development - Conceptual design - Detail design, Prototype fundamentals - Fundamentals of RP systems – RP process chain - 3D modelling -3D solid modeling software and their role in RPT - Data format - STL files- History of RP systems - Classification of RP systems - Benefits of RPT.

UNIT – II Liquid based RP Systems [09]

Liquid based RP systems: Stereo Lithography Apparatus (SLA): Principle, Photo polymers, Post processes, Process parameters, Machine details, Advantages. Solid Ground Curing (SGC): Principle, Process parameters, Process details, Machine details, Limitations. Solid Creation System (SCS): Principle, Process parameters, Process details, Machine details, Applications.

UNIT – III Solid based RP Systems [09]

Solid based RP systems: Fusion Deposition Modeling (FDM): Principle, Raw materials, BASS, Water soluble support system, Process parameters, Machine details, Advantages and limitations. Laminated Object Manufacturing (LOM): Principle, Process parameters, Process details, Advantages and limitations. Solid Deposition Manufacturing (SDM): Principle, Process parameters, Process details, Machine details, Applications.

UNIT – IV Powder based RP Systems [09]

Powder based RP systems: Selective Laser Sintering (SLS): Principle, Process parameters, Process details, Machine details, Advantages and applications. 3-Dimensional Printers (3DP): Principle, Process parameters, Process details, Machine details, Advantages and limitations. Laser Engineered Net Shaping (LENS): Principle, Process details, Advantages and applications.

UNIT – V Rapid Tooling and Applications of RP [09]

Rapid Tooling and Applications of RP-Different input data types- Direct Rapid Tooling, Indirect Rapid Tooling: Soft tooling and Hard tooling. Applications of RP in Product design, Automotive industry, and Medical field – Conversion of CT/MRI scan data - Customized implant - Case studies -Reverse engineering.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Chua.C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and Applications”, World scientific, New jersy, 2010.

2 Pham D.T. and Dimov S.S, “Rapid Manufacturing”, Springer -Verlag, London, 2011.

3 Amitabha Ghosh, “Rapid Manufacturing a brief Introduction”, Affiliated East West Press, New Delhi, 2011.

4 Gibson, I., Rosen, D.W. and Stucker, B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.

5 Liou, L.W. and Liou, F.W., Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, Second Edition, 2011

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20387	**ADVANCED METROLOGY AND NON DESTRUCTIVE TESTING (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	Demonstrate techniques used to quantify and comparison of products to required standards.	*Understand*
CO2:	Conversant with the newer technologies used in metrology.	*Understand*
CO3:	Design procedures which will incorporate quality in the product as per the customer's needs.	*Create*
CO4:	Demonstrate his or her knowledge in developing control mechanism to check variation in attributes and variables.	*Understand*
CO5:	Select suitable ND testing method for the contemporary issues.	*Remember*

UNIT – I INTRODUCTION [09]

Measuring Machines - Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Images shearing microscope- Use of computers- Machine vision technology - Microprocessors in metrology.

UNIT – II STATISTIAL QUALITY CONTROL [09]

Statistical Quality Control - Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - reliability and life testing.

UNIT – III BASIC NDT TESTS [09]

Liquid penetrants and magnetic particle tests - characteristics of liquid penetrants - different washable systems - Developers - applications - method of production of magnetic fields - Principles of operation of magnetic particle test - applications - Advantages and limitations.

UNIT – IV RADIOGRAPY [09]

Radiography - Sources of ray - x- ray production - properties of d and x rays - film characteristics – exposure charts- contrasts-operational characteristics of x ray equipment - applications.

UNIT – V ULTRASONIC TESTING METHODS [09]

Ultrasonic and acoustic emission techniques - Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method -A, B, C scans -Principles of acoustics emission technique - Advantage and limitations - Instrumentation – applications.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Jain,R.K."Engineering Metrology ", Khanna Publishers, 2009.

2 Barry Hull and Vernon John ," Non Destructive Testing ", Mac Millan, 2009

3 American Society for Metals ,"Metals Hand Book ", Vol II ,1976.

4 Progress in Acoustics Emission, " Proceedings of 10th International Acoustics Emission Symposium ", Japanese Society for NDI,1990.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20388	**OPTIMIZATION TECHNIQUES IN MANUFACTURING (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	Introduce the various optimization techniques.	*Understand*
CO2:	*Develop the classic optimization techniques*	*Apply*
CO3:	*Apply the non linear programming methods in optimum design*	*Apply*
CO4:	*Construct the dynamic programming and network techniques.*	*Apply*
CO5:	Apply the algorithms and simulation.	*Apply*

UNIT – I **INTRODUCTION** **[09]**

Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.

UNIT – II **CLASSIC OPTIMIZATION TECHNIQUES** **[09]**

Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.

UNIT – III **NON-LINEAR PROGRAMMING** **[09]**

Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming.

UNIT – IV **INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES** **[09]**

Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.

UNIT – V **ADVANCES IN SIMULATION** **[09]**

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 1997

2 J.K.Sharma, Operations Research – Theory and Applications – Macmillan India Ltd., 1997

3 P.K. Guptha and Man-Mohan, Problems in Operations Research – Sultan chand & Sons, 1994

4 R. Panneerselvam, “Operations Research”, Prentice Hall of India Private Limited, New Delhi 1 – 2005
Ravindran, Philips and Solberg, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 1992

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20389	**PLASTICS AND COMPOSITE MATERIALS (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	Select suitable plastics and composite materials for the required applications and its corresponding fabrication method.	*Apply*
CO2:	Identify the various process of involved in making plastics.	*Apply*
CO3:	Identify service requirements and how to relate materials to those requirements.	*Apply*
CO4:	*Develop various production process of polymer matrix composite.*	*Apply*
CO5:	Explore the charecteristics of metal matrix composie alloys.	*Understand*

UNIT – I INTRODUCTION [09]

Introduction – Chemistry and classification of Polymers – Properties of Thermo plastics Properties of Thermosetting plastics – Applications –Merits and Demerits.

UNIT – II PLASTICS PROCESS [09]

Processing of plastics – Extrusion – Injection Moulding -Blow Moulding – Compression And transfer Moulding – casting – Thermo Forming. Machining and joining of plastics – General Machining Properties of Plastics – Machining Parameters and their effect – joining of Plastics- Mechanical Fasteners – Thermal bonding – Press Fitting.

UNIT – III COMPOSITE MATERIALS [09]

Introduction to Composite Materials – Fibers – Glass, Boron , Carbon , Organic , Ceramic and Metallic Fibers – Matrix Materials – Polymers, Metals and Ceramics.

UNIT – IV POLYMER MATRIX COMPOSITES [09]

Processing of Polymer Matrix Composites – Open Mould Processes, Bag Moulding, Compression Moulding With BMS and SMS - Filament winding – Pultrusion - Centrifugal Casting – Injection Moulding – Application of PMC`s

UNIT – V METAL MATRIX COMPOSITES [09]

Processing of metal matrix composites – Solid State Fabrication Techniques – Diffusion Bonding – Powder Metallurgy Techniques – Plasma Spray, Chemical and Physical Vapour Deposition of Matrix on Fiber – Liquid State Fabrication Method – Infiltration – Squeeze Casting – Rheo Casting – Compocasting – Application of MMC`s.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1. Harold Belofsky, “Plastics: Product Design and Process Engineering”, Hanser Publishers, 1995.
2. Hensen.F, “Plastics Extrusion Technology”, Hanser Publishers, 1988.
3. Johnnaber F, “Injection Moulding Machines”, Hanser Publishesr, 1983.
4. Rosatao,D.V., “Blow Moulding Handbook”, Hanser Publishers, 1989.
5. Rauwendaal, C, “Polymer Extrusion”, Hanser Publishers, 1990.
6. A.K.B hargava, “Engineering Materials: Polymers, Ceramics and Composites”, Prentice-Hall of India Limited, New Delhi, 2005.
7. Bera, E and Moet, A, “High Performance Polymers”, Hanser Publisners ,1991

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20391	**MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	Knowledgeable in microstructure evaluation & crystal structure analysis.	*Understand*
CO2:	Gain knowledge in electron microscopy.	*Understand*
CO3:	Discover the Chemical and Thermal Analysis,.	*Analyze*
CO4:	Examine the static mechanical testing methods.	*Analyze*
CO5:	Inspect the dynamic mechanical testing methods.	*Analyze*

UNIT – I MICRO AND CRYSTAL STRUCTURE ANALYSIS [09]

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

UNIT – II ELECTRON MICROSCOPY [09]

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications-Atomic Force Microscopy- Construction & working of AFM - Applications .

UNIT – III CHEMICAL AND THERMAL ANALYSIS [09]

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravitymetric Analysis (TGA).

UNIT – IV MECHANICAL TESTING – STATIC TESTS [09]

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

UNIT – V MECHANICAL TESTING – DYNAMIC TESTS [09]

Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1. ASM Hand book-Materials characterization, Vol – 10, 2004.
2. Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.
3. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.
4. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
5. Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976.
6. Dieter G.E., Mechanical Metallurgy, (3rd Edition), ISBN: 0070168938, McGraw Hill, 1988.
7. Morita.S, Wiesendanger.R, and Meyer.E, "Non-contact Atomic Force Microscopy" Springer, 2002.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20392	**NON DESTRUCTIVE TESTING AND EVALUATION (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Explore the working principle, types and characteristics of various NDT processes.*	*.Understand*
CO2:	*Recognize different surface NDT methods and its applications*	*Understand*
CO3:	*Analyze the application of Thermography and Eddy current testing.*	*Analze*
CO4:	*Comprehend the Ultrasonic Testing and Acoustic Emission process.*	*Understand*
CO5:	*Apply the working principle and applications of Radiography techniques.*	*Apply*

UNIT – I OVERVIEW OF NDT [09]

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided

UNIT – II SURFACE NDE METHODS [09]

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT – III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) [09]

Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications.Eddy Current Testing- Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation

UNIT – IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) [09]

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications

UNIT – V RADIOGRAPHY (RT) [09]

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 ASM Metals Handbook,Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17 .

2 Dr.V.Jayakumar,Dr.K.Elangovan, Non-Destructive Testing of Materials, Lakshmi Publications,Chennai,2017.

3 Baldev Raj, T.Jayakumar, M.Thavasimuthu ,Practical Non-Destructive Testing, Narosa Publishing House, 2009 .

4 Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.

5 Charles, J. Hellier, Handbook of Nondestructive evaluation, McGraw Hill, New York , Second Edition,2001 .

6 Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, New Jersey, Second Edition,2005

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER –II / III

		L	T	P	C
IS20393	**LEAN MANUFACTURING (Elective)**	3	0	0	3

Prerequisite:

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	know the necessity for a Lean Manufacturing system	*Remembering*
CO2:	Differentiate between the conventional Mass production system with Lean system	*Analyzing*
CO3:	Effectively implement the principles of JIT	*Applying*
CO4:	Apply the Inspection tools effectively in the Lean systems	*Applying*
CO5:	Apply Hoshin planning system to create a Lean culture in Industry	*Applying*

UNIT - I INTRODUCTION: [09]

The mass production system – Origin of lean production system – Necessity – Lean revolution in Toyota – Systems and systems thinking – Basic image of lean production – Customer focus – Muda (waste).

UNIT - II STABILITY OF LEAN SYSTEM [09]

Standards in the lean system – 5S system – Total Productive Maintenance – standardized work – Elements of standardized work – Charts to define standardized work – Man power reduction – Overall efficiency - standardized work and Kaizen – Common layouts.

UNIT - III JUST IN TIME [09]

Principles of JIT – JIT system – Kanban – Kanban rules – Expanded role of conveyance – Production levelling – Pull systems – Value stream mapping**.**

UNIT - IV JIDOKA (AUTOMATION WITH A HUMAN TOUCH) [09]

Jidoka concept – Poka-Yoke (mistake proofing) systems – Inspection systems and zone control – Types and use of Poka-Yoke systems – Implementation of Jidoka.

UNIT - V WORKER INVOLVEMENT AND SYSTEMATIC PLANNING METHODOLOGY [09]

Involvement – Activities to support involvement – Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Phases of Hoshin Planning – Lean culture

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Dennis P.," Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", (Second edition), Productivity Press, New York,2007

2 Liker, J., "The Toyota Way: Fourteen Management Principles from the World's Greatest Manufacturer", McGraw Hill, 2004

3 Michael, L.G., "Lean Six SIGMA: Combining Six SIGMA Quality with Lean Production Speed", McGraw Hill, 2002

4 Ohno, T.," Toyota Production System: Beyond Large-Scale Production", Taylor & Francis, Inc., 1988.

5 Rother, M., and Shook, J.,' Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA", Lean Enterprise Institute, 1999.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER – II / III

		L	T	P	C
IS20394	**ADVANCES IN MANUFACTURING PROCESSES (Elective)**	3	0	0	3

Prerequisite:

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	Analyze the processes and evaluate the role of each process parameter during machining of various advanced materials	*Analyzing*
CO2:	Understand requirements to achieve maximum material removal rate and best quality of machined surface while machining various industrial engineering materials.	*Understanding*
CO3:	Analyze the different bulk metal forming process mechanics using different analysis	*Analyzing*
CO4:	Acquire the knowledge in mechanical micromachining processes.	*Remembering*
CO5:	Demonstrate the knowledge of Additive Manufacturing and Rapid Prototyping Technologies	*Understanding*

UNIT - I ENERGY ASSISTED MANUFACTURING PROCESSES [09]

Introduction – mechanism of materials removal and operating parameters of: Plasma Arc Machining – Laser Beam Machining – Electron Beam Machining – Electrical Discharge Machining – Ultrasonic Machining – Water Jet Machining – Abrasive water jet Machining – Abrasive jet Machining – Ion Beam Machining

UNIT - II PRECISION MACHINING [09]

. Electro chemical Machining- Ultra Precision turning and grinding- Chemical Mechanical Polishing (CMP) - ELID process – Partial ductile mode grinding-Ultra precision grinding- Binderless wheel – Free form optics. aspherical surface generation Grinding wheel- Design and selection of grinding wheel-High-speed grinding-High-speed milling- Diamond turning.

UNIT - III ADVANCES IN METAL FORMING [09]

Orbital forging, Isothermal forging, Warm forging, Overview of Powder Metal techniques –Hot and Cold isostatic pressing - high speed extrusion, rubber pad forming, Hydroforming, Superplastic forming, Peen forming-micro blanking –Powder rolling – Tooling and process parameters.

UNIT - IV MICRO MACHININING AND NANO FABRICATION [09]

Theory of micromachining – Micromachining Processes – Micro-milling – Micro-drilling – Micro-turning – Micro-grinding – Micro-polishing – Principle of Micro EDM – Micro wire EDM – Planetary Micro EDM – Reverse Micro EDM – Advantages, Challenges. Nano fabrication process - Nano machining techniques – Top / Bottom up Nano fabrication techniques - Sub micron lithographic technique, conventional film growth technique, Chemical etching, Quantum dot fabrication techniques – MOCVD – Epitaxy techniques.

UNIT - V RAPID PROTOTYPING AND SURFACE MODIFICATION TECHNIQUES [09]

Introduction – Classification – Principle advantages limitations and applications- Rapid Prototyping - Rapid Manufacturing - Rapid Tooling and Future Rapid Prototyping Processes -Stereolithography (SLA) – 3D Printing (3DP) – Selective Laser Sintering (SLS) – Laminated Object Manufacturing (LOM) – Fused Deposition Modelling (FDM) Introduction, Process descriptions, Materials, process variations, economic considerations, applications, design aspects and quality issues – CVD – PVD – Electroplating – Hot Dip Coating – Thermal Spraying.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Benedict,G.F.,"Non Traditional manufacturing Processes",CRC press,2011
2 Madou, M.J., Fundamentals of Micro fabrication: The Science of Miniaturization, Second Edition, CRC Press (ISBN: 0849308267),2006
3 McGeough,J.A.,"Advanced methods of Machining",Springer,2011
4 Narayanaswamy, R., Theory of Metal Forming Plasticity, Narosa Publishers,2000.
5 Pandey, P.S. and Shah.N., “Modern Manufacturing Processes”, Tata McGraw Hill, 2017.
6 Serope Kalpakjian., “Manufacturing Engineering and Technology” Pearson Education,2018

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER – II / III

		L	T	P	C
IS20395	**SMART MANUFACTURING (Elective)**	3	0	0	3

Prerequisite:

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	Appreciate concepts and basic framework necessary for smart manufacturing	*Remembering*
CO2:	Illustrate current trends at system level in manufacturing organizations	*Understanding*
CO3:	Use of Sensors and Selection of sensors for various applications	*Remembering*
CO4:	Construct IoT based manufacturing systems	*Applying*
CO5:	Discover the importance of industry 4.0 concepts at manufacturing systems	*Analyzing*

UNIT - I SENSORS SMART MANUFACTURING [09]

Introduction – Role of sensors in manufacturing automation – operation principles of different sensors – electrical, optical, acoustic, pneumatic, magnetic, electro-optical and vision sensors. Condition monitoring of manufacturing systems – principles – sensors for monitoring force, vibration and noise, selection of sensors and monitoring techniques. Automatic identification techniques for shop floor control – optical character and machine vision sensors – smart / intelligent sensors – integrated sensors, Robot sensors, Micro sensors, Nano sensors.

UNIT - II DATA ANALYTICS [09]

Introduction to Data and Analytics in a Digital Context (Internet of Things), Product Data Management for Design and Manufacturing (PLM Tools), Typical data challenges (data quality, enrichment, integration of ERP & PLM data), Preparing data for analytics (techniques to improve data quality, integration - ETL)

Advances in data visualization & related tools-Statistical Techniques for Analytics, Descriptive Statistics Inferential statistics, Regression and ANOVA

UNIT - III CYBER PHYSICAL SYSTEMS [09]

Concept of Cyber Physical Systems (CPS) and Cyber Physical Production System (CPPS), System Architecture for implementation of CPPS, Components for CPPS, Communication for CPPS

UNIT - IV E- MANUFACTURING [09]

Introduction of Agent based manufacturing- agent based Manufacturing, Cloud Based Manufacturing Information technology-based Supply chain, Concept of agile manufacturing and E-manufacturing

UNIT - V INDUSTRY 4.0 [09]

Evaluation of industries, Introduction to Industry 4.0, Challenges in industry 4.0, Impact of Industry 4.0, Case studies on industry 4.0, Introduction to Internet of Things (IoT) and its applications, Smart supply chain and Case studies.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1. Bahga and V. Madisetti, Internet of Things, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2014, ISBN: 978-0996025515
2. M. P. Grover “Automation, Production Systems and Computer-Integrated Manufacturing” Pearson Education, 4th Edition, 2016, ISBN: 978-0133499612
3. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: Cyber manufacturing Systems, Springer, 1st edition, 2017, ISBN: 978-3319425580
4. S. K. Saha, Introduction to Robotics, Tata Mcgraw Hill Education Private Limited, 2nd Edition, ISBN: 978-9332902800
5. M. Skilton and F. Hovsepian, The 4th Industrial Revolution: Responding to the Impact of Artificial Intelligence on Business, Springer Nature, 2017, ISBN: 978-3-319-62479-2

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20215	**SAFETY IN CHEMICAL INDUSTRIES (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Acquire knowledge on Chemical plant design, process, facilities and inherent safe design.*	*Understand*
CO2:	*Explore the commissioning phases and their documentation*	*.Understand*
CO3:	*Analyze the operating procedures and emergency procedures during plant operations.*	*Analyze*
CO4:	*Apply the concepts of plant maintenance, modification and emergency planning.*	*Apply*
CO5:	*Classify the different types of chemical storages and their safety measures.*	*Remember*

UNIT – I SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM [09]

Design process, conceptual design and detail design, assessment, inherently safer design - chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipments, utilities. Pressure system, pressure vessel design, standards and codes - pipe works and valves, heat exchangers - process machinery - over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations and disposal - flare and vent systems - failures in pressure system.

UNIT – II PLANT COMMISSIONING AND INSPECTION [09]

Commissioning phases and organization, pre-commissioning documents, process commissioning, commissioning problems, post commissioning documentation Plant inspection, pressure vessel, pressure piping system, non destructive testing, pressure testing, leak testing and monitoring - plant monitoring, performance monitoring, condition, vibration, corrosion, acoustic emission - pipe line inspection.

UNIT – III PLANT OPERATIONS [09]

Operating discipline, operating procedure and inspection, format, emergency procedures - hand over and permit system - start up and shut down operation, refinery units - operation of fired heaters, driers, storage - operating activities and hazards - trip systems - exposure of personnel.

UNIT – IV PLANT MAINTENANCE, MODIFICATION AND EMERGENCY PLANNING [09]

Management of maintenance, hazards - preparation for maintenance, isolation, purging, cleaning, confined spaces, permit system - maintenance equipment - hot works - tank cleaning, repair and demolition - online repairs - maintenance of protective devices, modification of plant, problems - controls of modifications. Emergency planning, disaster planning, onsite emergency - offsite emergency, APELL.

UNIT – V STORAGES [09]

General consideration, petroleum product storages, storage tanks and vessel - storages layout - segregation, separating distance, secondary containment - venting and relief, atmospheric vent, pressure, vacuum valves, flame arrestors, fire relief - fire prevention and protection - LPG storages, pressure storages, layout, instrumentation, vaporizer, refrigerated storages - LNG storages, hydrogen storages, toxic storages, chlorine storages, ammonia storages, other chemical storages - underground storages - loading and unloading facilities - drum and cylinder storage - ware house, storage hazard assessment of LPG and LNG.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Lees, F.P., Loss Prevention in Process Industries, Butterworths and Company, U.S., Fourth Edition, 2012.

2 Quantitative Risk Assessment in Chemical Process Industries, American Institute of Chemical Industries, Centre for Chemical Process safety, U.S., Second Edition,1999.

3 Fawcett, H.H. and Wood, Safety and Accident Prevention in Chemical Operations, Wiley inters, U.S., Second Edition, 2008.

4 Accident Prevention Manual for Industrial Operations, NSC, Chicago, Third edition, 2008.

5 GREEN, A.E., High Risk Safety Technology, John Wiley and Sons, U.K., Second Edition, 2003.

6 Petroleum Act and Rules, Government of India.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER- II / III

		L	T	P	C
IS20216	**SAFETY IN ENGINEERING INDUSTRY (Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Determine the General safety rules, principles, maintenance, Inspections of metal and wood working machinery*	*. Understand*
CO2:	*Apply the concepts of safety in design, use and maintenance of machines.*	*Apply*
CO3:	*Recall about welding, common hazards in welding, personal protective equipment and safety precautions in welding.*	*Understand*
CO4:	*Analyze the safety in cold working and hot working of metals.*	*.Analyze*
CO5:	*Acquire knowledge on safety in finishing, inspection and testing of machines.*	*. Understand*

UNIT - I SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES [10]

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes - saws, types, Hazards.

UNIT - II SAFETY IN DESIGN, USE & MAINTENANCE OF MACHINES [10]

Basic Principle of Machine guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS - guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing - guard construction - guard opening. Selection and suitability: lathe - drilling-boring - milling - grinding - shaping sawing - shearing - presses - forge hammer – flywheels - shafts - couplings - gears - sprockets wheels and chains - Pulleys and belts-authorized entry to hazardous installations - benefits of good guarding systems – introduction to sensors, instrumentation - types and measurement.

UNIT - III SAFETY IN WELDING AND GAS CUTTING [8]

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing - explosive welding, selection, care and maintenance of the associated equipment and instruments - safety in generation, distribution and handling of industrial gases - colour coding - flashback arrestor - leak detection - pipe line safety - storage and handling of gas cylinders.

UNIT - IV SAFETY IN COLD FARMING AND HOT WORKING OF METALS [10]

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot - operated presses, power press electric controls, power press set up and die removal, inspection and maintenance - metal shears-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills - hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.

UNIT - V SAFETY IN FINISHING, INSPECTION AND TESTING [7]

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry - pollution control in engineering industry - industrial waste disposal.

Total (L= 45, T = 0) = 45 Periods

Reference Books :

1 Occupational Safety Manual, BHEL, Trichy, Second Edition, 1988.
2 Accident Prevention Manual, NSC, Chicago, Third Edition, 2008.
3 Krishnan, N.V., Safety in Industry, Jaico Publishers House, London, Fourth Edition, 1996.
4 Safety in the use of wood working machines, HSE, UK, Second Edition, 2005.
5 Health and Safety in Welding and Allied Processes, Welding Institute, UK, High Tech. Publishing Ltd., London, Fifth Edition, 1989

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER – III

		L	T	P	C
IS20AU1	**ENGLISH FOR RESEARCH PAPER WRITING**	2	0	0	0

Course Outcomes : On Completion of this course, the student will be able to ***Cognitive Level***

CO1:	*Improve writing skills and level of readability.*	*Remember*
CO2:	*Recall about what to write in each section*	*. Understand*
CO3:	*Improve skills needed when writing a title, abstract and introduction.*	*Remember*
CO4:	*Improve skills needed when writing methods, results and discussion.*	*Understand*
CO5:	*Ensure the good quality of paper at very first time submission.*	*Remember*

UNIT - I **[6]**

Planning and Preparations, Word order, Breaking up long sentences, Structuring, Paragraphs and Sentences, Being concise and removing redundancy, Avoiding Ambiguity and vagueness.

UNIT - II **[6]**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing Paraphrasing and plagiarism, Sections of a paper, abstracts, Introduction, Review of the Literature, methods, results, discussions, conclusions, the final check.

UNIT - III **[6]**

Key skills are needed when writing a title, key skills are needed when writing an abstract, key skills are needed when writing an introduction, skills needed when writing a review of literature.

UNIT - IV **[6]**

Skills are needed when writing the methods, skills needed when writing the results, skills are needed when writing the discussion, skills are needed when writing the conclusions.

UNIT - V **[6]**

Useful phrases, how to ensure paper is as good as it could possibly the first time submission.

Total (L= 30, T = 0) = 30 Periods

Reference Books :

1 Adrian Wallwork, English for Writing Research Papers, Springer New York ,Dordrecht Heidelberg London, Second Edition, 2011.

2 Day R, How to write and publish a scientific paper, Cambridge University Press, US, Seventh Edition, 2006.

3 Goldbort R, Writing for Science, Yale University Press, New York, Third Edition, 2006.

4 Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book, UK, 1998.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - III

		L	T	P	C
IS20321	**PROJECT PHASE - I**	0	0	12	6

Prerequisite:

Course Outcomes : On Completion of this course, the student will be able to		***Cognitive Level***
CO1:	*Identify real time problems.*	Applying
CO2:	*Acquire knowledge on the industrial oriented projects.*	Understanding
CO3:	*Collect the data from the literature surveys and able to find out the solutions.*	Creating
CO4:	*Select the topic based on the critical problems and hazards identified.*	Analyzing
CO5:	*Apply the solutions for the problems identified.*	Evaluating

1. Every student shall have a supervisor who is the member of the faculty of the institution. Identification of student and his faculty supervisor has to be completed within the first two weeks from the day of beginning of third semester.
2. The students should make industrial visits, identify real time problems and submit reports.
3. In consultation with supervisor, the problem has to be selected.
4. Preferably it can be a collaborative project with industry.
5. A detailed study of the problem and its financial implications and physical and mental hazards can be studied.
6. The methodology to tackle this problem can be studied and analyzed.
7. A mini project report should be submitted at the end of the semester as per guidelines.
8. This project report should be evaluated jointly by external and internal examiners.

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - IV

		L	T	P	C
IS20421	**PROJECT PHASE - II**	0	0	24	12

Prerequisite:

Course Outcomes : On Completion of this course, the student will be able to		***Cognitive Level***
CO1:	*Identify real time problems.*	Applying
CO2:	*Extend knowledge on the industrial oriented projects.*	Understanding
CO3:	*Collect the data from the literature surveys and able to find out the solutions.*	Creating
CO4:	*Classify the topic based on the critical problems and hazards identified.*	Analyzing
CO5:	*Justify the solutions for the problems identified.*	Evaluating

1. The supervisor allotted for project phase I will continue to supervise project phase II.
2. As per methodology suggested in phase I, the project can be implemented.
3. Outcome of implementation can be studied and each student shall finally produce a comprehensive report covering back ground information, literature survey, problem statement, results and discussions with conclusion.
4. This final report shall be in type written form as specified in the guidelines.
5. The project report should be evaluated jointly by external and internal examiners.