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File Ref.No.KTU/ASST11(ADMIN)/3212/2022

APJ Abdul Kalam Technological University
Thiruvananthapuram

Abstract

APJAKTU-Academic - - Curriculum and detailed Syllabus of S1 and S2 M. Tech (Industrial Safety and Engineering) approved by the Academic council of TKM College of Engineering - resolution ivide item no 023.3.36 of the Academic Council-implemented-Orders Issued

ACADEMIC SECTION

U.O.No. 1598/2023/KTU Thiruvananthapuram, Dated: 30.06.2023

Read:-1. Letter No.F.22-1/2022(AC) dated 26.05.22 from University Grants Commission, Ministry of Education, Government of India.

2. University Grants Commission (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2018 Dated 12.02.2018.

3. U.O No.2153/2022/KTU dated 2.09.2022

4. NOTIFICATION No. KTU/ASST11(ADMIN)/3212/2022 02.09.2022

5. Letter No. ACU3/1083/2022 dated 12/04/2023

6.Minutes of the meeting of the 23rd meeting of the Academic Council held on 09/06/2023, vide item no.023.3.06

ORDER

The APJ Abdul Kalam Technological University has notified the TKM College of Engineering, Kollam as an autonomous college affiliated with the University with effect from 02.09.2022, vide ref(4) notification. Clause 13.1 of UGC regulations,2018 empowers an autonomous college to constitute an Academic Council to ensure proper academic management.

Vide ref. read as (5) above, the Principal, TKM College of Engineering Kollam has forwarded the curriculum and detailed syllabus of S1 and S2 for M. Tech (Industrial Safety and Engineering), the first autonomous batch, as approved by the Academic Council of the TKM College of Engineering. The matter was placed before the Academic Council of the University.

The 23 rd meeting of the Academic Council vide item no.023.3.06 resolved to approve the curriculum and detailed syllabus of **M. Tech (Industrial Safety and Engineering)** for the

first autonomous batch, which was approved by the Academic Council of the TKM College of Engineering Vide reference read as (6) above,

Sanction is accorded by the Vice chancellor to implement the resolution of the Academic Council to approve the curriculum and detailed syllabus of S1 and S2 (attached as annexure) for **M. Tech (Industrial Safety and Engineering)** for the first autonomous batch, which was approved by the Academic Council of the TKM College of Engineering.

Orders are issued accordingly.

Sd/-

Dr. VINU THOMAS *
Dean (Academic)

Copy to:-

1.The Principal,TKM College of Engineering
2.PA to Dean Academic
3.PS to VC
4.PA to Controller of Examinations
5.AD(IT)

Forwarded / By Order

Section Officer

* This is a computer system (Digital File) generated letter. Hence there is no need for a physical signature.

TKM COLLEGE OF ENGINEERING

(Government Aided and Autonomous)

celebrating 60 years of excellence

M TECH 2022 CURRICULUM

Discipline: Chemical Engineering
Stream: Industrial Safety and Engineering

SEMESTER I

SLOT	COURSE CODE	COURSE NAME	MARKS		L-T-P	HOURS	CREDIT
			CIA	ESE			
A	221TCH101	PROBABILITY AND RELIABILITY FOR SAFETY ENGINEERING.	40	60	3-0-0	3	3
B	221TCH102	SAFETY IN CHEMICAL INDUSTRIES	40	60	3-0-0	3	3
C	221TCH103	SAFETY MANAGEMENT	40	60	3-0-0	3	3
D	221ECHxxx	PROGRAM ELECTIVE 1	40	60	3-0-0	3	3
E	221ECHxxx	PROGRAM ELECTIVE 2	40	60	3-0-0	3	3
S	221RGE100	RESEARCH METHODOLOGY AND IPR	40	60	2-0-0	2	2
T	221LCH001	INDUSTRIAL SAFETY LABORATORY - I	100	--	0-0-2	2	1
Total			**340**	**360**		**19**	**18**

Teaching Assistance: 6 hours

PROGRAM ELECTIVE 1						
SLOT	**SL NO**	**COURSE CODE**	**COURSE NAME**	**L-T-P**	**HOURS**	**CREDIT**
D	1	221ECH101	OCCUPATIONAL HEALTH & SAFETY LEGISLATIONS	3-0-0	3	3
	2	221ECH103	SAFETY IN ONSHORE AND OFFSHORE DRILLING	3-0-0	3	3
	3	221ECH105	INDUSTRIAL INSTRUMENTATION & CONTROL	3-0-0	3	3
	4	221ECH107	SAFETY IN ELECTRICAL SYSTEMS	3-0-0	3	3
	5	221ECH109	SAFETY IN CRYOGENIC MATERIAL HANDLING / PROCESSING	3-0-0	3	3
	6	221ECH111	SAFETY IN CONSTRUCTION	3-0-0	3	3

PROGRAM ELECTIVE 2						
SLOT	**SL NO**	**COURSE CODE**	**COURSE NAME**	**L-T-P**	**HOURS**	**CREDIT**
E	1	221ECH102	HUMAN FACTOR ENGINEERING	3-0-0	3	3
	2	221ECH104	FOOD SAFETY MANAGEMENT SYSTEMS & SANITATIONS	3-0-0	3	3
	3	221ECH106	DESIGN OF POLLUTION CONTROL SYSTEMS	3-0-0	3	3
	4	221ECH108	SAFETY IN HEALTH CARE WASTE MANAGEMENT	3-0-0	3	3
	5	221ECH110	PIPING ENGINEERING DESIGN & ANALYSIS	3-0-0	3	3
	6	221ECH112	FUEL & COMBUSTION TECHNOLOGY	3-0-0	3	3

SEMESTER II

SLOT	COURSE CODE	COURSE NAME	MARKS		L-T-P	HOURS	CREDIT
			CIA	ESE			
A	222TCH201	FIRE ENGINEERING AND EXPLOSION CONTROL	40	60	3-0-0	3	3
B	222TCH202	RISK ANALYSIS AND HAZARD ASSESSMENT	40	60	3-0-0	3	3
C	222ECHxxx	PROGRAM ELECTIVE 3	40	60	3-0-0	3	3
D	222ECHxxx	PROGRAM ELECTIVE 4	40	60	3-0-0	3	3
E	222ECHxxx	INDUSTRY/ INTERDISCIPLINARY ELECTIVE	40	60	3-0-0	3	3
S	222PCH100	MINI PROJECT	100	--	0-0-4	4	2
T	222LCH002	INDUSTRIAL SAFETY LABORATORY - II	100	--	0-0-2	2	1
Total			**400**	**300**		**21**	**18**

Teaching Assistance: 6 hours

PROGRAM ELECTIVE 3						
SLOT	**SL NO**	**COURSE CODE**	**COURSE NAME**	**L-T-P**	**HOURS**	**CREDIT**
C	1	222ECH201	PROCESS MODELLING & SIMULATION	3-0-0	3	3
	2	222ECH203	DISASTER MANAGEMENT & EMERGENCY PLANNING	3-0-0	3	3
	3	222ECH205	COMPUTER PROGRAMMING & SOFTWARE TOOLS IN HAZARD ANALYSIS	3-0-0	3	3
	4	222ECH207	SAFETY IN MATERIAL HANDLING	3-0-0	3	3
	5	222ECH209	SAFETY IN ENGINEERING INDUSTRIES	3-0-0	3	3
	6	222ECH211	INDUSTRIAL NOISE & VIBRATION CONTROL	3-0-0	3	3

PROGRAM ELECTIVE 4						
SLOT	**SL NO**	**COURSE CODE**	**COURSE NAME**	**L-T-P**	**HOURS**	**CREDIT**
D	1	222ECH202	SAFETY IN HAZARDOUS MATERIAL TRANSPORT	3-0-0	3	3
	2	222ECH204	NUCLEAR ENGINEERING & SAFETY	3-0-0	3	3
	3	222ECH206	DESIGN & ANALYSIS OF EXPERIMENTS	3-0-0	3	3
	4	222ECH208	DESIGN OF INDUSTRIAL VENTILATION SYSTEMS	3-0-0	3	3
	5	222ECH210	SAFETY IN HIGH-PRESSURE SYSTEMS & VACUUM TECHNOLOGY	3-0-0	3	3
	6	222ECH212	SAFETY IN MINES & POWER PLANTS	3-0-0	3	3

INTERDISCIPLINARY ELECTIVE						
SLOT	**SL NO**	**COURSE CODE**	**COURSE NAME**	**L-T-P**	**HOURS**	**CREDIT**
E	1	222ECH214	PROCESS SAFETY ENGINEERING	3-0-0	3	3
	2	222ECH216	WASTE TO ENERGY CONVERSION	3-0-0	3	3
	3	222ECH218	HYDROGEN ENERGY: PRODUCTION, STORAGE, TRANSPORTATION & SAFETY	3-0-0	3	3

SEMESTER III

SLOT	COURSE CODE	COURSE NAME	MARKS		L-T-P	HOURS	CREDIT
			CIA	ESE			
TRACK 1							
A*	223MCHxxx	MOOC	To be completed successfully		--	--	2
B	223AGExxx	AUDIT COURSE	40	60	3-0-0	3	--
C	223ICH100	INTERNSHIP	50	50	--	--	3
D	223PCH100	DISSERTATION PHASE 1	100	--	0-0-17	17	11
TRACK 2							
A*	223MCHxxx	MOOC	To be completed successfully		--	--	2
B	223AGExxx	AUDIT COURSE	40	60	3-0-0	3	-
C	223ICH100	INTERNSHIP	50	50	---	--	3
D	223PCH101	RESEARCH PROJECT PHASE 1	100	--	0-0-17	17	11
Total			**190**	**110**		**20**	**16**

Teaching Assistance: 6 hours

*MOOC Course to be successfully completed before the commencement of the fourth semester (starting from semester 1).

AUDIT COURSE						
SLOT	**SL NO**	**COURSE CODE**	**COURSE NAME**	**L-T-P**	**HOURS**	**CREDIT**
B	1	223AGE100	ACADEMIC WRITING	3-0-0	3	-
	2	223AGE101	ADVANCED ENGINEERING MATERIALS	3-0-0	3	-
	3	223AGE102	FORENSIC ENGINEERING	3-0-0	3	-
	4	223AGE103	DATA SCIENCE FOR ENGINEERS	3-0-0	3	-
	5	223AGE104	DESIGN THINKING	3-0-0	3	-
	6	223AGE105	FUNCTIONAL PROGRAMMING IN HASKELL	3-0-0	3	-
	7	223AGE106	FRENCH LANGUAGE (A1 LEVEL)	3-0-0	3	-
	8	223AGE107	GERMAN LANGUAGE (A1 LEVEL)	3-0-0	3	-
	9	223AGE108	JAPANESE LANGUAGE (N5 LEVEL)	3-0-0	3	-
	10	223AGE109	PRINCIPLES OF AUTOMATION	3-0-0	3	-
	11	223AGE110	REUSE AND RECYCLE TECHNOLOGY	3-0-0	3	-
	12	223AGE111	SYSTEM MODELING	3-0-0	3	-
	13	223AGE112	EXPERT SYSTEMS	3-0-0	3	-

SEMESTER IV

SLOT	COURSE CODE	COURSE NAME	MARKS		L-T-P	HOURS	CREDIT
			CIA	ESE			
TRACK 1							
A	224PCH100	DISSERTATION PHASE II	100	100	0-0-24	24	16
TRACK 2							
A	224PCH001	RESEARCH PROJECT PHASE II	100	100	0-0-24	24	16
Total			**100**	**100**		**24**	**16**

Teaching Assistance: 5 hours

ASSESSMENT PATTERN

(i) CORE COURSES

The evaluation shall only be based on application, analysis or design-based questions (for both internal end-semester examinations).

Continuous Internal Evaluation: 40 marks

Micro project/Course based project: 20 marks

Course-based task/Seminar/Quiz: 10 marks

Test paper, 1 No: 10 marks

The project shall be done individually. Group projects not permitted. Test paper shall include a minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

(ii) ELECTIVE COURSES

The evaluation shall only be based on application, analysis or design-based questions (for both internal and end-semester examinations)

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer-reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course-based task/Seminar/Data collection and interpretation: 15 marks Test

paper, 1 No.: 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

(iii) RESEARCH METHODOLOGY & IPR/AUDIT COURSE

Continuous Internal Evaluation: 40 marks

Course-based task: 15 marks

Seminar/Quiz: 15 marks

Test paper, 1 No.: 10 marks

Test paper shall include a minimum 80% of the syllabus.

End Semester Examination: 60 marks

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which students should answer any five. Each question can carry 12 marks.

(iv) LABORATORY COURSES

The laboratory courses will be having only Continuous Internal Evaluation and carries 100 marks. Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

(v) INTERDISCIPLINARY ELECTIVE

Engineering students frequently aspire to work in areas and domains that are key topics in the industry.

There are concerns by recruiters that skill sets of engineering students did not match with the Industry requirements, especially in the field of latest topics. In response to their desires, the University has incorporated Industry/Interdisciplinary electives in the curriculum. Interdisciplinary knowledge is critical for connecting students with current industry trends, where multitasking is the norm. Interdisciplinary knowledge aids in the bridge- building process between academic institutions and industry. It aids pupils in expanding their knowledge and innovating by allowing them to create something new. While core engineering courses provide students with a strong foundation, evolving technology necessitates new methods and approaches to progress, prosperity, and the inculcation of problem-solving techniques. Other courses' knowledge, on the other hand, can assist them to deal with any scenario more effectively. Interdisciplinary courses may be one approach to address such needs, as they can aid in the enhancement of engineering education and the integration of desirable specialized subjects into the current engineering education system. This will enable students to fulfil the current industry demands. Students with multidisciplinary knowledge and projects are more likely to be placed in top industries, according to the placement trend. The future of developing engineers will be influenced by their understanding of emerging technology and interdisciplinary approaches such as big data, machine learning, and 3-D printing.

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer-reviewed

Original publications (minimum 10 publications shall be referred): 15 marks

Course-based task/Seminar/Data collection and interpretation: 15 marks Test

paper, 1 No: 10 marks

Test paper shall include a minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry7 marks.

(vi) MOOC COURSES

The MOOC course shall be considered only if it is conducted by the agencies namely

AICTE/NPTEL/SWAYAM or NITTTR. The MOOC course should have a minimum duration of 8 weeks and the content of the syllabus shall be enough for at least 40 hours of teaching. The course should have a proctored/offline end-semester examination. The students can do the MOOC according to their convenience but shall complete it by the third semester. The list of MOOC courses will be provided by the concerned BoS if at least 70% of the course content match with the area/stream of study. The course shall not be considered if its content has more than 50% of overlap with a core/elective course in the concerned discipline or with an open elective. MOOC Course to be successfully completed before the commencement of fourth semester (starting from semester 1). A credit of 2 will be awarded to all students who ever successfully complete the MOOC course as per the evaluation pattern of the respective agency conducting the MOOC.

(vii) MINIPROJECT

Total marks: 100, only CIA

Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem-solving skills. The introduction of mini projects ensures the preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with PG Programme Coordinator that should lead to their dissertation/research project. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Interim evaluation: 40 (20 marks for each review), final evaluation by a Committee (will be evaluating the level of completion and demonstration of functionality/specifications, clarity of presentation, oral examination, work knowledge and involvement): 35, Report (the committee will be evaluating for the technical content, adequacy of references, templates followed and permitted plagiarism level is not more than 25%): 15, Supervisor/Guide: 10

TEACHING ASSISTANTSHIP (TA)

All M Tech students irrespective of their category of admission shall undertake TA duties for a minimum duration as per the curriculum. Being a TA, the student will get an excellent opportunity to improve their expertise in the technical content of the course, enhance communication skills, obtain a hands-on experience in handling the experiments in the laboratory and improve peer interactions.

The possible TA responsibilities include the following: facilitate a discussion section or tutorial for a theory/ course, facilitate to assist the students for a laboratory course, serve as a mentor for students, and act as the course web-master. TAs may be required to attend the instructor's lecture regularly. A TA shall not be employed as a substitute instructor, where the effect is to relieve the instructor of his or her teaching responsibilities (specifically prohibited by University Policy).

For the tutorial session:

(i) Meet the teacher and understand your responsibilities well in advance, attend the lectures of the course for which you are a tutor, work out the solutions for all the tutorial problems yourself, approach the teacher if you find any discrepancy or if you need help in solving the tutorial problems, use reference text books, be innovative and express everything in English only.

(ii) Try to lead the students to the correct solutions by providing appropriate hints rather than solving the entire problem yourself, encourage questions from the students, lead the group to a discussion based on their questions, plan to ask them some questions be friendly and open with the students, simultaneously being firm with them.

(iii) Keep track of the progress of each student in your group, give periodic feedback to the student about his/her progress, issue warnings if the student is consistently under-performing, report to the faculty if you find that a particular student is consistently underperforming, pay special attention to slow-learners and be open to the feedback and comments from the students and faculty.

(iv) After the tutorial session you may be required to grade the tutorials/assignments/tests. Make sure that you work out the solutions to the questions yourself, and compare it with the answer key, think and work out possible alternate solutions to the same question, understand the marking scheme from the teacher. Consult the teacher if you are not partial to some student/students while grading. Follow basic ethics.

Handling a laboratory Session:

(i) Meet the faculty – in- charge a few days in advance of the actual lab class and get the details of the experiment, get clarifications from him/her regarding all aspects of the experiment and the expectations, prepare by reading about the theoretical background of the experiment, know the physical concepts involved

in the experiment, go to the laboratory and check out the condition of the equipment/instrumentation, perform the laboratory experiment at least once one or two days before the actual laboratory class, familiarize with safety/ security aspects of the experiment/equipment/laboratory, prepare an instruction sheet for the experiment in consultation with the faculty, and keep sufficient copies ready for distribution to students for their reference.

(ii) Verify condition of the equipment/set up about 30 minutes before the students arrive in the class and be ready with the hand outs, make brief introductory remarks about the experiment, its importance, its relevance to the theory they have studied in the class, ask the students suitable questions to know their level of preparation for the experiment, discuss how to interpret results, ask them comment on the results.

(iii) Correct/evaluate/grade the submitted reports after receiving suitable instructions from the faculty in charge, continue to interact with students if they have any clarifications regarding any aspect of the laboratory session, including of course grading, Carefully observe instrument and human safety in laboratory class, Preparing simple questions for short oral quizzing during explanation of experiments enables active participation of students, facilitate attention, provides feedback and formative assessment.

TKM COLLEGE OF ENGINEERING

(Government Aided and Autonomous)

celebrating 60 years of excellence

M TECH 2022
SYLLABUS
FIRST AND SECOND SEMESTER

Discipline: Chemical Engineering
Stream: Industrial Safety and Engineering

221TCH101	PROBABILITY AND RELIABILITY FOR SAFETY ENGINEERING	CATEGORY	L	T	P	CREDIT
		PCC	3	0	0	3

Preamble: To equip the students to extract information from the data to interpret the information and to draw calculations.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply standard and special probability distributions to safety engineering problems
CO 2	Indicate data pictorially and numerically and analyse it.
CO 3	Understand t-test, F-test and Chi-square test in determining the validity of data.
CO 4	Predict the relationship between parameters through correlation and regression analysis and compute the reliability of safety systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3			3	3		
CO 2	3			3	3		
CO 3	3			3	3		
CO 4	3			3	3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60 %
Analyse	40 %
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

CORE COURSES

Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

Micro project/Course based project:	20 marks
Course based task/Seminar/Quiz:	10 marks
Test paper, 1 no.:	10 marks

The project shall be done individually. Group projects not permitted. Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Model Question paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221TCH101

Max. Marks: 60 Duration: 150 minutes

PROBABILITY AND RELIABILITY FOR SAFETY ENGINEERING

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Explain discrete and continuous random variable with an example.
2. Differentiate the recurrence relation in any two special distributions.
3. Briefly explain Type I and Type II errors.
4. Explain least square method for curve fitting.
5. Explain failure rate analysis.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Determine a Poisson Distribution to the following data using recurrence formula

X	0	1	2	3	4	5	Total
f	142	156	69	27	5	1	400

7. Show that Normal distribution is symmetrical distribution
8. What will be the probability in Weibull distribution of a magnetic disk failing before 500 hours if the disk is exposed to corrosive gas. The value of γ and α is 300 and 0.5.
9. Random samples of 400 men and 600 women were asked whether they would like to have a Flyover near their residence. 200 men and 325 women were in favour of the proposal. Test the hypothesis that proportions of men and women in favour of the proposal are same, at 5% Level (Difference of two proportions).
10. A pair of dice are thrown 360 times and frequencies of each sum is indicated below Would you say that the dice are fair on the basis of the Chi-Sqare test at 0.01 Level of Significance.

Sum	2	3	4	5	6	7	8	9	10	11	12
Frequency	8	24	35	37	44	65	51	42	26	14	14

11. Find the value of a, b and c so that $y = a + bx + cx^2$ is the best fitting of each of the data given below :

x	0	1	2	3	4

y	1	0	3	10	21

12. An electronic device works for 24 hrs daily and continuously for 60days. The following components listed below are used for the construction.

Components	Number used	Failure rates (%per 1000hrs)	Rating
Transistors	30	0.08	2
Diodes	4	0.05	1.5
Caapcitors	100	0.01	3
Resistors	140	0.05	2
Connectors	700	0.001	1

Calculate the system reliability if the environmental and temperature weighing factors for all the components are given by 2.0 and 1.5 respectively.

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SYLLABUS
MODULE I (8 hrs)
Random variable – Two dimensional random variables – Standard probability distributions – Binomial, Poisson and Normal distributions - Moment generating function.
MODULE II (8 hrs)
Special distributions – Uniform, Geometric, Exponential, Gamma, Weibull and Beta distributions – Mean, Variance, Raw moments from moment generating functions of respective distributions.
MODULE III (8 hrs)
Sampling distributions – Confidence interval estimation of population parameters – Testing of hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test.
MODULE IV (8 hrs)
Curve fitting - Method of least squares - Regression and correlation – Rank correlation – Multiple and partial correlation – Analysis of variance - One way and two way classifications – Time series analysis.
MODULE V (10 hrs)
Basics concepts of reliability - Failure rate analysis – Reliability of systems – Series, Parallel – Maintenance - Preventive and corrective – Maintainability equation – Availability – Quality and Reliability. Introduction to data analytical and data mining

Course Plan

No	Topic	No. of Lectures
1	**MODULE I (8 hrs)**	
1.1	Random variable – Two dimensional random variables	4
1.2	Standard probability distributions – Binomial, Poisson and Normal distributions - Moment generating function.	4
2	**MODULE II (8 hrs)**	
2.1	Random variable – Two dimensional random variables	4
2.2	Standard probability distributions – Binomial, Poisson and Normal distributions - Moment generating function.	4
3	**MODULE III (8 hrs)**	
3.1	Sampling distributions – Confidence interval estimation of population parameters	3
3.2	Testing of hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test	5
4	**MODULE IV (8 hrs)**	
4.1	Curve fitting - Method of least squares - Regression and correlation – Rank correlation – Multiple and partial correlation	5
4.2	Analysis of variance - One way and two way classifications – Time series analysis	3

5	**MODULE V (10 hrs)**	
5.1	Basics concepts of reliability - Failure rate analysis – Reliability of systems – Series, Parallel – Maintenance - Preventive and corrective – Maintainability equation – Availability – Quality and Reliability.	7
5.2	Introduction to data analytical and data mining	3

REFERENCES:

1. Johnson R J,miller & Freunds “Probability and Statistics for Engineers” 6th Edition, Prentice hall of India(2002).
2. Gupta S.C and Kapoor V K “Fundamentals of Mathematical Statistics” S Chandan and sons, New Delhi.
3. Bowker and Liberman, Engineering Statistics, Prentice-Hall.
4. Spiegel, Murray R., Probability and Statistics, Schaum’s series.
5. Trivedi K.S., Probability and Statistics with Reliability and Queuing and Computer Science Applications, Prentice Hall of India.

221TCH102	SAFETY IN CHEMICAL INDUSTRIES	CATEGORY	L	T	P	CREDIT
		PCC	3	0	0	3

Preamble:

The objective of this course is to enhance knowledge on safe design, operation, inspection, and maintenance of chemical process plants and equipment, material safety data sheet (MSDS) of chemicals, and on-site and off-site emergency preparedness in a chemical process industry.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe chemical plant design, process, facilities, statues, and inherent safe design.
CO 2	Explain pre- and post-plant commissioning and prepare inspection reports with HMIS labelling, and documentation.
CO 3	Formulate procedures for operation, inspection, and emergency procedures for the chemical industry.
CO 4	Explain work permit systems and perform a permit-to-work procedure prior to undertaking experimental work or pilot plant operation.
CO 5	Devise emergency preparedness and plan to mitigate emergency situations.
CO 6	Interpret the material safety data sheet (MSDS) of chemicals and explain the factors to be considered during the storage and transport of petroleum products and various other chemicals.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			2	2	3	1	
CO 2			2	2	3	1	
CO 3			2	2	3	1	
CO 4			2	2	3	1	
CO 5			2	2	3	1	
CO 6			2	2	3	1	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60 %
Analyse	40 %
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks
Micro project/Course based project: 20 marks
Course based task/Seminar/Quiz : 10 marks
Test paper, 1 no. : 10 marks

The project shall be done individually. Group projects not permitted. Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks
The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Model Question paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221TCH102

Max. Marks: 60 Duration: 150 minutes

SAFETY IN CHEMICAL INDUSTRIES

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question. (5x 5 = 25)

1. List and explain any four steps to prevent local stress in a pressure vessel design.
2. What is conceptual design? Explain its elements and requirements for a good conceptual design.
3. Explain the importance of work permit system in process industry.
4. Explain the importance of HAZCHEM code in Transportation of chemicals.
5. One thousand Kilograms of methane escapes from a storage vessel, mixes with air and explodes. Determine the equivalent amount of TNT assuming an explosion efficiency of 2%. The Heat of combustion of methane is 818.7KJ/mol and energy of explosion of TNT is 4686KJ/kg.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain various engineering and operational design aspects that are to be considered while formulating industrial safety standard and codes in a chemical process industry.
7. List the various procedures to be followed to ensure safe commissioning activities. Elaborate in detail.
8. Describe various NDT techniques to be followed during the testing of high-pressure piping system.
9. Explain the requirements for storage of chemicals in a manner that is safe and in accordance with the Dangerous Goods Safety Management Regulations.
10. Explain in detail, the causes of serious accidents in the chemical industries during the maintenance work in equipment and precautions to avoid such accidents.
11. Describe the main purposes of providing secondary containment. Also explain various provisions given in the storage of chemicals in a tank farm.
12. Explain hazard prevention measures to be followed in a ware house storage to store different kinds of materials.

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SYLLABUS
MODULE I (8 hrs)
Safety in Process Design and Pressure System Design: 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 equipment, utilities. Pressure system, pressure vessel design, standards and codes- pipe works and valves heat exchangers- process machinery- overpressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems- failures in pressure system.
MODULE II (8 hrs)
Plant Commissioning and Inspection: Commissioning phases and organization, pre-commissioning documents, process commissioning, commissioning problems, and 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.
MODULE III (8 hrs)
Plant Operations: Operating discipline, operating procedure and inspection, format, emergency procedures hand over and permit system- startup and shutdown operation, refinery units- operation of fired heaters, driers, storage- operating activities and hazards- trip systems- exposure of personnel. Specific safety considerations for Cement, paper, pharmaceutical, petroleum, petrochemical, rubber, fertilizer, and distilleries.
MODULE IV (8 hrs)
Plant Maintenance, Modification & Emergency Planning: 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.
MODULE V (8 hrs)
Storages & Transport: General consideration, petroleum product storage, 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 storage, 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- warehouse, storage hazard assessment of LPG and LNG. Hazards during transportation – pipeline transport

Course Plan

No	Topic	No. of Lectures
1	**MODULE I (8 hrs)**	
1.1	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 equipment, utilities.	4
1.2	Pressure system, pressure vessel design, standards and codes- pipe works and valves heat exchangers- process machinery- overpressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems- failures in pressure system.	4
2	**MODULE II (8 hrs)**	
2.1	Commissioning phases and organization, pre-commissioning documents, process commissioning, commissioning problems, and post-commissioning documentation.	4
2.2	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.	4
3	**MODULE III (8 hrs)**	
3.1	Operating discipline, operating procedure and inspection, format, emergency procedures hand over and permit system- startup and shutdown operation	3
3.2	refinery units- operation of fired heaters, driers, storage- operating activities and hazards- trip systems- exposure of personnel.	2
3.3	Specific safety considerations for Cement, paper, pharmaceutical, petroleum, petrochemical, rubber, fertilizer, and distilleries.	3
4	**MODULE IV (8 hrs)**	
4.1	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.	5
4.2	Emergency planning, disaster planning, onsite emergency- offsite emergency, APELL.	3
5	**MODULE V (8 hrs)**	
5.1	General consideration, petroleum product storage, storage tanks and vessel- storages layout- segregation, separating distance, secondary containment- venting and relief, atmospheric vent, pressure, vacuum	4

	valves, flame arrestors, fire relief- fire prevention and protection- LPG storages, pressure storage, layout, instrumentation, vaporizer	
5.2	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- warehouse, storage hazard assessment of LPG and LNG.	3
5.3	Hazards during transportation – pipeline transport	1

Reference Books

1. Lees, F.P., “Loss Prevention in Process Industries” Butterworth publications, London, 3rd edition, 2005.
2. Sanoy Banerjee, “Industrial hazards and plant safety”, Taylor & Francis, London, 2003.
3. Fawcett, H., and Wood, “Safety and Accident Prevention in Chemical Operations” Wiley inters, 2nd Edition, 1984.
4. McElroy, Frank E., “Accident Prevention Manual for Industrial Operations”, NSC, Chicago, 1988.
5. Green, A.E., “High-Risk Safety Technology”, John Wiley and Sons, 1984.

221TCH103	SAFETY MANAGEMENT	CATEGORY	L	T	P	CREDIT
		PCC	3	0	0	3

Preamble: The course is designed to give the fundamental understanding of safety management functions and techniques, accident reporting and investigation along with safety education and training.

Course Outcomes: After the completion of the course the student will be able to

CO 1	apply principles of safety management, its functions and technique in any organization
CO 2	prepare safety audit report
CO 3	formulate accident investigation program in an organization, develop and practice accident reporting system
CO 4	recognize the importance of safety education and training in an organization
CO 5	practice safety professional ethics
CO 6	identify and comply with statutory and regulatory requirement

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3				
CO 2		3	3	3			
CO 3		3	3				
CO 4			2				
CO 5						3	
CO 6			2			2	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications (minimum 10

publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:
The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.
Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.
Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry
7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark
% for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %. Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221TCH103

Max. Marks: 60 Duration: 150 minutes

SAFETY MANAGEMENT

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Give a brief outline on Incident Recall Technique
2. Compare Safety Audit and Safety Inspection
3. Distinguish between reportable and non-reportable accidents
4. Mention some problems of safety activity rate.
5. Mention the role of government and private consulting agencies in safety management.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the functions of safety management in detail.
7. Form your own check list for safety audit to a textile industry-and explain the need of each one
8. Prepare a detailed self-contained accident investigation report including the causation factors.
9. Explain the chief components of safety budget? What are the proposals that should go into safety budget? Give one such proposal.
10. Assume that you have just joined as a safety officer with an industry which already has the problems of more accidents, poor adherence to wearing of PPE by the employees, poor involvement of various categories of employees in Safety, etc. As a Safety officer, Explain your strategies and efforts proposed for solving the same.
11. Justify and explain" the statement "Accident cost is a only a tip of an Ice berg".
12. How an accident is documented, investigated, and analysed? Explain the procedure with an example.

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SYLLABUS
MODULE I
CONCEPTS and TECHNIQUES- Henrich's Axioms Of Industrial Safety- Evolution of modern safety concept- Safety as integral part of business- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety. Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety.
MODULE II
SAFETY AUDIT – 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.
MODULE III
ACCIDENT INVESTIGATION AND REPORTING- Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee – Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports, Class exercise with case study.
MODULE IV
SAFETY PERFORMANCE MONITORING Reactive and proactive monitoring techniques - 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. **SAFETY EDUCATION AND TRAINING** Importance of training-identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - 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.
MODULE V
EFFECTIVE SAFETY MANAGEMENT SYSTEM AND ETHICS- Purpose, Safety Culture, Safety functions, Elements of process safety management, Behavior Based Safety, Elements of Safety Management System, Concept of BBIP, OSHA guidelines, Voluntary Safety and Health Program management guidelines, 1989, Introduction, basic principles, duties and obligations, conditions of execution of the functions of occupational safety professionals.

Course Plan

No	Topic	No. of Lectures
1	**CONCEPTS and TECHNIQUES (8hrs)**	
1.1	Henrich's Axioms of Industrial Safety- Evolution of modern safety concept	1
1.2	Safety as integral part of business- Safety policy - Safety Organization	1
1.3	Line and staff functions for safety- Safety Committee- budgeting for safety	2
	Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA)	2
1.4	Safety survey, safety inspection, safety sampling	1
1.5	Evaluation of performance of supervisors on safety	1
2.	**SAFETY AUDIT (8hrs)**	
2.1	Components of safety audit, types of audit, audit methodology	2
2.2	Non-conformity reporting (NCR), audit checklist and report	1
2.3	Review of inspection, remarks by government agencies, consultants, experts	1
2.4	Perusal of accident and safety records, formats – implementation of audit indication	2
2.5	Liaison with departments to ensure co-ordination – check list	1
2.6	Identification of unsafe acts of workers and unsafe conditions in the shop floor	1
3	**ACCIDENT INVESTIGATION AND REPORTING(8hrs)**	
3.1	Concept of an accident, reportable and non reportable accidents, unsafe act and condition	1
3.2	Principles of accident prevention, Supervisory role- Role of safety committee	1
3.3	Accident causation models - Cost of accident	1
3.4	Overall accident investigation process - Response to accidents, India reporting requirement	1
3.5	Planning document, Planning matrix, Investigators Kit, functions of investigator	1
3.6	Four types of evidences, Records of accidents, accident reports	1
3.7	Class exercise with case study	2
4	**SAFETY PERFORMANCE MONITORING & SAFETY EDUCATION AND TRAINING(10 hrs)**	
4.1	Reactive and proactive monitoring techniques - Permanent total disabilities, permanent partial disabilities, temporary total disabilities	2
4.2	Calculation of accident indices, frequency rate, severity rate	1
4.2	Frequency severity incidence, incident rate, accident rate, safety "t" score	1

4.4	Safety activity rate – problems	1
4.5	Importance of training-identification of training needs-training methods	1
4.6	Programme, seminars, conferences, competitions – method of promoting safe practice	1
4.7	Motivation – communication - role of government agencies and private consulting agencies in safety training	1
4.8	Creating awareness, awards, celebrations, safety posters, safety displays, safety pledge	1
4.9	Safety incentive scheme, safety campaign – Domestic Safety and Training	1
5	**EFFECTIVE SAFETY MANAGEMENT SYSTEM AND ETHICS**	
5.1	Purpose, Safety Culture, Safety functions, Elements of process safety management	1
5.2	Behavior Based Safety, Elements of Safety Management System	1
5.3	Concept of BBIP, OSHA guidelines, Voluntary Safety and Health Program management guidelines, 1989	2
5.4	Introduction, basic principles, duties and obligations, conditions of execution of the functions of occupational safety professionals	2

Reference Books

1. Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 1982

2.Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.

3. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.

4. Roland P. Blake , "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973

5. "Industrial safety management", L M Deshmukh, TATA McGraw Hill, 2010.

6. "Industrial safety management", L M Deshmukh, TATA McGraw Hill, Fourth edition, 2010.

7. Lees, F.P., "Loss Prevention in Process Industries" Butterworth publications, London, 2nd edition, 1990.

8.John Ridley, "Safety at Work", Butterworth and Co., London, Sixth edition 2003.

9.Dan Petersen, "Techniques of Safety Management", McGraw-Hill Company, Tokyo, 1981.

10.Relevant India Acts and Rules, Government of India.

11.Relevant Indian Standards and Specifications, BIS, New Delhi.

12."Safety and Good House Keeping", N.P.C., New Delhi, 1985.

221ECH101	OCCUPATIONAL HEALTH AND SAFETY LEGISLATIONS	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

The aim of this course is to imbibe knowledge on workplace hazards and control strategies to control the hazards and to promote awareness on occupational health and prevention of occupational diseases.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify different physical, chemical and biological hazards in the workplaces, and analyse work environment.
CO 2	Recommend control measures for different types of physical, chemical and biological hazards in the workplaces, and be able to choose between different control strategies
CO 3	Select appropriate protective devices based on hazard characterization.
CO 4	Formulate plans for promotion of occupational health and prevention of occupational diseases
CO 5	Gain knowledge on laws relevant and concerning towards welfare, working hours and health and safety of workers engaged in industries.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			2				
CO 2			2				
CO 3			2	1			
CO 4			2				
CO 5			2				

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10

publications shall be referred) : 15
marks Course based task/Seminar/Data collection and interpretation : 15
marks Test paper, 1 no. : 10
marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry
7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20= 60 %. Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 221ECH101

Max. Marks: 60 Duration: 150 minutes

OCCUPATIONAL HEALTH AND SAFETY LEGISLATIONS

PART – A

Answer All the Questions.
One question from each module, having 5 marks for each question.
(5x 5 = 25)

1.Explain the factors that influence the effects of exposure to Hand-arm vibration, and elaborate various standards related to Hand-arm vibration.
2.A large chemical spillage is to be cleaned with a flammable solvent manually. Explain the possible health effect upon exposure to the solvent.
3.Describe how buildings should be designed to control biological hazards. Also explain on what basis the biological safety cabinets are assigned.
4.Enumerate and explain the safety precautions that should be implemented to avoid occupational asthma.
5.Explain in detail about the different health provisions listed in the Factories Act, 1948.

PART – B

Minimum one question from each module (Total seven questions)
Answer any five (5 x 7 = 35)

6.Over the past several months, the medical personnel at Barsten Products has spoken to number of employees who have complained about ringing in their ears toward the end of their shifts. Before the complaints started about three months ago, Barsten Products had not had any noise problems at its plant. In reviewing their files with Barsten's industrial hygienist, the medical staff found that first complaint was made shortly after the company purchased a new machine for trimming metal. According to the manufacturer’s recommendations, earmuffs should be worn when operating the machine. The industrial hygienist confirmed that employees working with the machine had been fitted for earmuffs; however, he also noted that some of the employees needed to wear protective eyewear at the same time. When the medical personnel and the industrial hygienist discussed the issue with Barsten's management, management was extremely concerned about the complaints leading to determinations of occupational hearing loss. The decision was made to re-evaluate the risk factors for hearing loss and the company's testing program. You are a member of the team assigned to re-evaluate the noise levels at the plant and the company's testing program. Reassess the testing program and give suggestions based on your assessment.
7.Air contains 10 ppm of diethylamine (TLV-TWA of 10 ppm), 30 ppm of cyclohexano (TLV- TWA of 50 ppm), and 25 ppm of propylene oxide (TLV-TWA of 20 ppm). Find out The mixture TLV-TWA and justify whether the level is exceeded by explaining in detail about TLV and TWA.
8.Explain in detail about Biohazard control program, employee health program and laboratory safety program?
9. Asbestos is having properties that is required for number of application in industries but at the same time, it is very harmful. Explain in brief its uses and harmful effects.

10. A worker is employed in a factory on monthly wage of Rs. 9,000. While working, he met with an accident and resulted in Total Disablement on 14th October 2005. His date of birth is 15th June 1985. Analyse the total payable compensation to the worker based on the Workmen's Compensation Act.
11. List out and explain different types of air sampling and equipment used.
12."Damage to hearing occurs when noise levels are higher than 85 decibels " Analyse the statement and explain the noise exposure limits and the risk factors involved.

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SYLLABUS
MODULE I (9 hrs)
PHYSICAL HAZARDS Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control program, industrial audiometry, hearing conservation programs vibration types, effects, instruments, surveying procedure, permissible exposure limit. Ionizing radiation, types, effects, monitoring instruments, control programs, 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
MODULE II (8 hrs)
CHEMICAL HAZARDS Recognition of chemical hazards-dust, fumes, mist, vapour, 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 Vapour monitors, dust sample collection devices, personal sampling Methods of Control - Engineering Control, Design maintenance considerations, design specifications - General Control Methods - training and education
MODULE III (7 hrs)
BIOLOGICAL HAZARDS Classification of Biohazardous agents –bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases - Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design
MODULE IV (8 hrs)
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
MODULE V (8 hrs)

Occupational Safety and Health Legislations – ISO 45000, ISO 14000, ILO Conventions, NIOSH, EPA, The Workmen's Compensation Act, OHSAS 18001, Mines Act.1952, The Factories Act, 1948, Water (Prevention & control of pollution) Act, 1974 and Air (Prevention & control of pollution) Act, 1981. Dock Workers (Safety, Health and Welfare) Act, 1986; Plantation Labor Act, 1951; Explosives Act,1884; Petroleum Act; 1934; Insecticide Act, 1968; Indian Boilers Act, 1923; Dangerous Machines (Regulations) Act, 1923; Indian Atomic Energy Act, 1962.Radiological Protection Rules; 1971. Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989; Electricity Act, 2002

Course Plan

No	Topic	No. of Lecture
1	**MODULE I (9 hrs)**	
1.1	PHYSICAL HAZARDS Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control program, industrial audiometry, hearing conservation programs vibration types, effects, instruments, surveying procedure, permissible exposure limit. -	3
1.2	Ionizing radiation, types, effects, monitoring instruments, control programs, OSHA standard	2
1.3	Non-ionizing radiations, effects, types, radar hazards, microwaves and radio-waves, lasers, TLV	2
1.4	Cold environments, hypothermia, wind chill index, control measures-	1
1.5	Hot environments, thermal comfort, heat stress indices, acclimatization, estimation and control	1
2	**MODULE II (8 hrs)**	
2.1	CHEMICAL HAZARDS Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. dose, TLV.	1
2.2	Methods of Evaluation, process or operation description, Field Survey, Sampling methodology	1
2.3	Industrial Hygiene calculations, Comparison with OSHAS Standard.	1
2.4	Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures	2
2.5	Gas and Vapour monitors, dust sample collection devices, personal sampling	1
2.6	Methods of Control - Engineering Control, Design maintenance considerations, design specifications - General Control Methods - training and education	2
3	**MODULE III (7 hrs)**	
3.1	BIOLOGICAL HAZARDS Classification of Biohazardous agents – bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases - -	3
3.2	Biohazard control program, employee health program-laboratory safety program	3
3.3	Animal care and handling-biological safety cabinets - building design	1
4	**MODULE IV (8 hrs)**	
4.1	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, ,.	2

4.2	Notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax, lead-nickel, chromium and manganese toxicity.	2
4.3	Gas poisoning (such as CO, ammonia, coal and dust etc.,) their effects and prevention – cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests.	2
4.4	Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems	2
5	**MODULE V (8 hrs)**	
5.1	Occupational Safety and Health Legislations – ISO 45000, ISO 14000, ILO Conventions, NIOSH, EPA.	2
5.2	The Workmen's Compensation Act, OHSAS 18001, Mines Act.1952, The Factories Act, 1948, Water (Prevention & control of pollution) Act, 1974 and Air (Prevention & control of pollution) Act, 1981.	2
5.3	Dock Workers (Safety, Health and Welfare) Act, 1986; Plantation Labor Act, 1951; Explosives Act,1884; Petroleum Act; 1934; Insecticide Act, 1968; Indian Boilers Act, 1923;	2
5.4	Dangerous Machines (Regulations) Act, 1923; Indian Atomic Energy Act, 1962.Radiological Protection Rules; 1971. Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989; Electricity Act, 2002	2

Reference Books

1. Handbook of Occupational Health and Safety, NSC Chicago, vol 1, 2 1982.
2. Encyclopedia of Occupational Health and Safety, Vol. I & II, International Labour Organisation, Geneva, 1985.
3. Daniel A. Crowl, Joseph F. Louvar. Chemical Process Safety: Fundamentals with Applications, Prentice Hall (2011).
4. Barbara A. Plog. Patricia J. Quinlan, Fundamentals of Industrial Hygiene (5^{th} edition), National Safety Council Chicago, 5^{th} Edition (2001).

221ECH103	SAFETY IN ONSHORE AND OFFSHORE DRILLING	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

The aim of the course is to familiarize the students with the hazards and risks prevailing in petrochemical industries. The course also introduces the measures taken to improve health and safety in petrochemical industries.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the health and safety issues involved in the processing of petroleum products
CO 2	Interpret the hazards associated with drilling of oil and petroleum extraction and employ control measures to ensure safe working environment
CO 3	Practice standard operating procedures for safe handling and storage of petroleum products.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3	2			
CO 2			3	2	2		
CO 3			3	2			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	-
Create	-

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60%.

Total duration of the examination will be 150 minutes**.**

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 221ECH103

Max. Marks: 60 **Duration: 150 minutes**

SAFETY IN ONSHORE AND OFFSHORE DRILLING

PART – A

Answer all the questions.

(5x 5 = 25)

1.Classify petroleum products
2.Describe the extraction and transport of petroleum crude by sea
3.Describe the factors affecting purging and causes of dilution.
4.Describe the hazard control monitoring methodologies practiced in offshore platforms.
5.List the impact caused by oil and gas industries on the Marine Environment.

PART – B

Answer any five (5 x 7 = 35)

6. Describe the construction and installation of pipelines for offshore oil operation. List the safety precautions to be taken while installing pipelines.
7.Describe the working conditions and safety associated hazards while drilling crude oil.
8.Describe the Process Safety Management (PSM) at oil and gas operations. List the exemptions of PSM standards in oil and gas industries.
9.Compare Protection System Design and Operation explosion Prevention Systems.
10.Describe any two accidents that occurred in Sleipner A Platform and Thunde Horse Platform.
11.Write a note on pollution due to produced water during drilling operations. List the drilling discharges and the methods adopted to control oil spill.
12.Describe the safe work practices for load lifting, excavations and hazardous environments.

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Syllabus
Module 1 (8 hours)
Petroleum and Petroleum products – Fuels, Petroleum solvents, Lubricating oils, Petroleum wax, greases, Miscellaneous product On and off shore oil operation: Construction and Installation – Pipe line Construction, Maintenance and repair activities, Safety and associated hazards
Module 2 (8 hours)
Drilling oil – Technique and equipment, Work position, Working condition, safety and associated hazards, lighting and its effects Petroleum Extraction and transport by sea, Oil field products, Operation, Transport of crude by sea, Crude oil hazards, Petroleum product storage and transport, Storage equipment, Precaution, Tank cleaning.
Module 3 (9 hours)
Safety Measures in Design and Operation-Introduction- Inerting or Purging, Terminologies, Factors Affecting Purging, Causes of Dilution or Mixing. Limits of Flammability of Gas Mixtures, Protection System Design and Operation Explosion Prevention Systems. Limits of Flammability of Gas Mixtures, Protection System Design and Operation Explosion Prevention Systems. Safe Work Practices-Load Lifting, Confined Space, Excavations, and Hazardous Environments. Process Safety Management (PSM) at Oil and Gas Operations, Exemptions of PSM Standards in Oil and Gas Industries, Process Safety Information
Module 4 (7hours)
Accidents in Offshore Platforms, Sleipner A Platform, Thunder Horse Platform, Timor Sea Oil Rig, Bombay High North in Offshore Mumbai, Hazard Evaluation and Control-Hazard Evaluation, Hazard Classification, Hazard Control, Monitoring.
Module 5 (9 hours)
Impact of Oil and Gas Industries on Marine Environment- Drilling Operations and Consequences, Main Constituents of Oil-Based Drilling Fluid, Pollution Due to Produced Waters During Drilling, Drilling Accidents- Underwater Storage Reservoirs, Chemicals and Wastes from Offshore Oil Industry, Drilling Discharges, Control of Oil Spill, Environmental Management Issues-Environmental Protection: Principles Applied to Oil and Gas Activities

Course Plan

No	Topic	No. of lectures
	Module 1(8 hrs)	
1.1	Petroleum and Petroleum products – Fuels On and off-shore oil operation – Maintenance and repair activities, Safety and associated hazards	2
1.2	Petroleum solvents – Lubricating oils,Petroleum wax, greases, – Miscellaneous product	1
1.3	Construction and Installation – Pipeline Construction	3
1.4	Maintenance and repair activities – Safety and associated hazards	2
	Module 2(8 hrs)	
2.1	Drilling oil – Technique and equipment, Work position.	2
2.2	safety and associated hazards, lighting and its effects.	1
2.3	Petroleum Extraction and transport by sea, Oil field products, Operation	2
2.4	Transport of crude by sea, Crude oil hazards.	2
2.5	Petroleum product storage and transport, Storage equipment, Precaution, Tank cleaning.	1
	Module 3(9 hrs)	
3.1	Safety Measures in Design and Operation-Introduction- Inerting or Purging, Terminologies, Factors Affecting Purging, Causes of Dilution or Mixing	2
3.2	Limits of Flammability of Gas Mixtures, Protection System Design and Operation Explosion Prevention Systems	3
3.3	Safe Work Practices-Load Lifting, Confined Space, Excavations, and Hazardous Environments	2
3.4	Process Safety Management (PSM) at Oil and Gas Operations, Exemptions of PSM Standards in Oil and Gas Industries, Process Safety Information	2
	Module 4(7 hrs)	
4.1	Accidents in Offshore Platforms, Sleipner A Platform,	1
4.2	Thunder Horse Platform, Timor Sea Oil Rig	2
4.3	Bombay High North in Offshore Mumbai,	1
4.4	Hazard Evaluation and Control- Hazard Evaluation, Hazard Classification, Hazard Control, Monitoring	3
	Module 5(9 hrs)	
5.1	Impact of Oil and Gas Industries on Marine Environment- Drilling Operations and Consequences, Main Constituents of Oil-Based Drilling Fluid, Pollution Due to Produced Waters During Drilling	2
5.2	Drilling Accidents- Underwater Storage Reservoirs	1
5.3	Chemicals and Wastes from Offshore Oil Industry	1
5.4	Drilling Discharges, Control of Oil Spill	1

5.5	Environmental Management Issues-Environmental Protection: Principles Applied to Oil and Gas Activities.	2
5.6	Working condition, safety and associated hazards, lighting and its effects	2

References

1. Health, Safety, and Environmental Management in Offshore and Petroleum Engineering, Srinivasan Chandrasekaran, 2016 John Wiley & Sons, Ltd.
2. Encyclopedia of Occupational Health and Safety, Vol. II, International Labour Organisation, Geneva, 1985 & I.

221ECH105	INDUSTRIAL INSTRUMENTATION & CONTROL	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

The aim of the course is to familiarize the students with various types of temperature, pressure, level, and flow measurement devices and also to introduce the basic operation of control valves, various types of control valves, and control valve accessories. This course also aims to provide an introduction to process control and P&ID diagrams.

Course Outcomes: After the completion of the course, the student will be able to

CO 1	Select different temperature and pressure measuring instruments based on the requirement and explain the working principle and measurement techniques of these instruments.
CO 2	Explain the working principle and measurement techniques of various types of level measuring instruments.
CO 3	Explain the physics of flow measurement, linearization, compensation, and calibration in flow measurement, and describe different types of flow measurement devices and their selection.
CO 4	Identify and classify the use of instruments in process industries and select the appropriate instrument for a given process measurement problem.
CO 5	Identify different P&ID symbols and apply the P&ID concepts for industrial applications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			2	2	3	1	
CO 2			2	2	3	1	
CO 3			2	2	3	1	
CO 4			2	2	3	1	
CO 5			2	2	3	1	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyse	40
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end-semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem-solving and quantitative evaluation), with a minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end-semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECH105

Max. Marks: 60 Duration: 150 minutes

INDUSTRIAL INSTRUMENTATION & CONTROL

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question. (5 x 5 = 25)

1. Write short notes about accuracy, precision, repeatability and reproducibility of an instrument.
2. Explain how Bernoulli's energy relation is employed in Pitot tube for flow measurement.
3. Giving a neat diagram explain the construction and working of resistance type level detectors.
4. Describe the principle of working of resistance thermometers. List out the commonly used sensing element materials in resistance thermometers.
5. Illustrate the symbols of any ten chemical apparatus or equipment used in P and I Diagram.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Making use of a neat sketch explain the construction and working of capacitance type level gauge for non-conducting liquids.
7. With the help of a neat sketch, explain how a McLeod gauge helps accurate measurement of pressure.
8. Explain the sources of errors and precautions to be taken in temperature measurements using liquid filled thermometers.
9. Describe the principle of working of quantity meters, head meters, variable area flow meter and open channel flow meters with two examples each.
10. Give justification for why you would choose a venturi-meter over an orifice meter for measuring flow of a fluid that has to be transported over long distances. Explain the principle involving the working of the venturi-meter.
11. Draw the P&I diagram for a system where the feed goes into a shell and tube heat exchanger to get heated up by superheated steam.
12. Describe the arrangement of thermocouples for the measurement of average temperature of a room

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SYLLABUS
MODULE I (10 hrs)
Fundamental & Importance of Instrumentation, types of instruments, selection of instruments, the performance of instruments, error in measurement, Introduction to Transducer & types, Process Instrumentation, recording instruments, indicating & recording Instruments. Pressure Measurement: Mechanical devices like Diaphragm, Bellows, and Bourdon tube for pressure measurement, Variable inductance, and capacitance transducers, Piezoelectric transducers, and L.V.D.T. for measurement of pressure. Temperature measurement: Introduction to temperature measurements, Resistance type temperature sensors – RTD & Thermistor, Thermocouples & Thermopiles, Laws of thermocouples, Fabrication of industrial thermocouples, Radiation methods of temperature measurement.
MODULE II (8 hrs)
Flow measurement: Introduction, definition and units, classification of flow meters, differential pressure and variable area flow meters, Positive displacement flow meters, Electro Magnetic flow meters, Hot wire anemometer, and ultrasonic flow meters. Calibration and selection of Flow meters. Level measurement: Introduction, Differential pressure level detectors, Capacitance level sensor, Ultrasonic level detectors, and Radar level transmitters and gauges.
MODULE III (7 hrs)
Elements of control systems, the concept of open loop and closed loop systems, Examples and application of open loop and closed loop systems, brief idea of multivariable control systems. A brief idea of proportional, derivative, and integral controllers. Selection and Application: Selection and application of temperature, pressure, flow, and level measuring instruments.
MODULE IV (6 hrs)
Standards and Calibration: Introduction to standards and calibration, calibration of temperature, pressure, and flow measuring devices. Introduction to ISO, IEC, and API standards pertaining to temperature, pressure, and flow instrumentation. Valves: Control valves - design of actuators and positioners - types of valve bodies -valve characteristics- materials for body and trim - sizing of control valves - selection of body materials and characteristics of control valves for typical applications.
MODULE V (9 hrs)
Flow sheet design: Types of flow sheets, flow sheet presentation, flow sheet symbols, line symbols and designation, process flow diagram, synthesis of steady state flowsheet. Piping and instrumentation diagram evaluation and preparation: P&ID Symbols, line numbering, line schedule, P&ID development, various stages of P&ID, P&ID for pumps, compressors, process vessels, absorbers, and evaporators. Control systems and interlocks for process operation: Introduction and description, need of interlock, types of interlocks, interlock for pumps, compressor, heater-control system for heater, distillation column, expander.

Course Plan

No	Topic	No. of Lectures
1	**MODULE I (10 hrs)**	
1.1	Fundamental & Importance of Instrumentation, types of instruments, selection of instruments, the performance of instruments, error in measurement	1
1.2	Introduction to Transducer & types, Process Instrumentation, recording instruments, indicating & recording Instruments.	1
1.3	Pressure Measurement: Mechanical devices like Diaphragm, Bellows, and Bourdon tube for pressure measurement, Variable inductance, and capacitance transducers, Piezoelectric transducers, and L.V.D.T. for measurement of pressure.	4
1.4	Temperature measurement: Introduction to temperature measurements, Resistance type temperature sensors – RTD & Thermistor	2
1.5	Thermocouples & Thermopiles, Laws of thermocouples, Fabrication of industrial thermocouples	1
1.6	Radiation methods of temperature measurement.	1
2	**MODULE II (8 hrs)**	
2.1	Flow measurement: Introduction, definition and units, classification of flow meters, differential pressure and variable area flow meters, Positive displacement flow meters	2
2.2	Electro Magnetic flow meters, Hot wire anemometer, and ultrasonic flow meters. Calibration and selection of Flowmeters	2
2.3	Level measurement: Introduction, Differential pressure level detectors, Capacitance level sensor	2
2.4	Ultrasonic level detectors, and Radar level transmitters and gauges	2
3	**MODULE III (7 hrs)**	
3.1	Elements of control systems, the concept of open loop and closed loop systems, Examples and application of open loop and closed loop systems, brief idea of multivariable control systems.	3
3.2	A brief idea of proportional, derivative, and integral controllers.	1
3.3	Selection and Application: Selection and application of temperature, pressure, flow, and level measuring instruments.	3
4	**MODULE IV (6 hrs)**	
4.1	Standards and Calibration: Introduction to standards and calibration, calibration of temperature, pressure, and flow measuring devices.	2
4.2	Introduction to ISO, IEC, and API standards pertaining to temperature, pressure, and flow instrumentation.	1
4.3	Valves: Control valves - design of actuators and positioners - types of valve bodies -valve characteristics- materials for body and trim - sizing of	3

	control valves - selection of body materials and characteristics of control valves for typical applications.	
5	**MODULE V (9 hrs)**	
5.1	Flow sheet design: Types of flow sheets, flow sheet presentation, flow sheet symbols, line symbols and designation, process flow diagram, synthesis of steady state flowsheet.	3
5.2	Piping and instrumentation diagram evaluation and preparation: P&ID Symbols, line numbering, line schedule, P&ID development, various stages of P&ID, P&ID for pumps, compressors, process vessels, absorbers, and evaporators.	3
5.3	Control systems and interlocks for process operation: Introduction and description, need of interlock, types of interlocks, interlock for pumps, compressor, heater-control system for heater, distillation column, expander.	3

Reference Books

1. Jain. R. K, “Mechanical and Industrial Measurements”, Khanna Publishers.
2. Patranabis D, “Principles of Industrial Instrumentation”, Tata McGraw Hill.
3. Andrew and Williams, “Applied Instrumentation in Process Industries”, Gulf publications Volume 1,2.
4. Anil Kumar, Chemical Process Synthesis and Engineering Design, Tata McGraw Hill, New Delhi,1981.
5. A.N. Westerberg et al., Process Flow sheeting, Cambridge University Press, NewDelhi,1979.
6. Moe Toghraei., Piping and Instrumentation Diagram Development, Wiley-AIChE Publication. 2019.
7. Jagadeesh Pandiyan., Introduction to Smart Plant (R) P&ID: The Piping and Instrumentation Diagrams (P&ID) Handbook, APJ Books Publisher, 2020 Edition.

221ECH107	SAFETY IN ELECTRICAL SYSTEMS	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: To study the basic concepts of electrical hazards, protection systems, regulations and statutory requirements relevant to electrical safety

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the phenomenon of electrical hazards associated causes, effects and prevention/protection measures
CO 2	Recognize the extreme importance of observing all safety requirements and practices connected with electricity
CO 3	Enumerate legislative background for electrical safety (codes/standards/acts/rules, etc.,)
CO 4	Elucidate the causes, phenomenon and effects of static charge generation and discharge, and prevention/protection measures

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3	3	3	3	
CO 2			3		3	3	
CO 3		3				3	3
CO 4	3			3			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyse	40
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECH107

Max. Marks: 60 Duration: 150 minutes

SAFETY IN ELECTRICAL SYSTEMS

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Write a short note on functional responsibilities of electrical inspectorate.
2. Define primary and secondary hazards in Electrical systems.
3. Distinguish between no load protection and earth fault protection.
4. List the preventive measures adopted in cabling.
5. Describe the use of barriers and isolators in electrical safety.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Describe the first aid measures adopted in electrical hazards.
7. Describe the safety measure in handling the war equipments.
8. Explain the regulations of national electrical safety codes.
9. Explain the personal protective equipments used in electrical safety.
10. Describe the different types of Circuit breakers.
11. Explain work permit system with its merits and demerits.
12. Describe the classifications of hazardous zones.

****

SYLLABUS
MODULE I (8 hrs)
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).
MODULE II (10 hrs)
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. Lightning, hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth pit maintenance.
MODULE III (10 hrs)
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.
MODULE IV (6hrs)
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.
MODULE V (6 hrs)
Classification of hazardous zones -intrinsically safe and explosion proof electrical apparatus (IS, API and OSHA standard) -increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies.

Course Plan

No	Topic	No. of Lectures
1	**MODULE I (8 hrs)**	
1.1	Introduction – electrostatics, electro magnetism, stored energy, energy radiation and electromagnetic interference – Working principles of electrical equipment.	3
1.2	Indian electricity act and rules-statutory requirements from electrical inspectorate-international standards on electrical safety.	3
1.3	First aid-cardio pulmonary resuscitation (CPR).	2
2	**MODULE II (10 hrs)**	
2.1	Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity.	1
2.2	Energy leakage-clearances and insulation-classes of insulation-voltage classificationsexcess energy-current surges-	1
2.3	Safety in handling of war equipments-over current and short circuit current-heating effects of current--electromagnetic forces-corona effect	2
2.4	Static electricity – definition, sources, hazardous conditions, control, electrical causes of fire and explosionionization, spark and arc-ignition energy-national electrical safety code ANSI.	4
2.5	Lightning, hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth pit maintenance.	2
3	**MODULE III (10 hrs)**	
3.1	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.	4
3.2	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-	3
3.3	Personal protective equipment – safety in handling hand held electrical appliances tools and medical equipments	3
4	**MODULE IV (6 hrs)**	
4.1	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	4
4.2	Safety in the use of portable tools-cabling and cable joints preventive maintenance	2
5	**MODULE V (6 hrs)**	

5.1	Classification of hazardous zones -intrinsically safe and explosion proof electrical apparatus (IS, API and OSHA standard)	3
5.2	Increase safe equipment-their selection for different zones temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies	3

REFERENCES

1. Fordham Cooper, W., "Electrical Safety Engineering" Butterworth and Company, London, 1986.
2. S. Rao, Prof. H.L. Saluja, "Electrical safety, fire safety Engineering and safety management",Khanna Publishers. New Delhi, 1988.(units-I to V)
3. "Accident prevention manual for industrial operations", N.S.C.,Chicago, 1982.
4. Indian Electricity Act and Rules, Government of India.
5. Power Engineers – Handbook of TNEB, Chennai, 1989.
6. Martin Glov Electrostatic Hazards in powder handling, Research Studies Pvt.LTd., England, 1988
7. www.osha.gov

221ECH109	SAFETY IN CRYOGENIC MATERIAL HANDLING/PROCESSING	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: The aim of this course is to be aware of the various hazards associated with cryogenic material handling and the measures to control these hazards

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand cryogenic fluid properties
CO 2	Be aware of hazards associated with cryogenic systems and the recommended hazard mitigation techniques
CO 3	Have an increased awareness of common accident scenarios

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1					2	2	
CO 2				3	3	2	2
CO 3							

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 =60%

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECH109

Max. Marks: 60 Duration: 150 minutes

SAFETY IN CRYOGENIC MATERIAL HANDLING / PROCESSING

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Explain the primary hazards associated with the use of cryogenic fluids.
2. List out the major hazards of liquid hydrogen.
3. Explain about the flammability hazards of cryogenics.
4. Suggest any two compatible materials used for cryogenic applications.
5. List any two control measures for possibility of fire in Cryogenic applications.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Write a short note on physical and chemical hazards of cryogens.
7. Enumerate the safety precautions to be considered in the storage of liquid hydrogen.
8. List out the major hazards associated with the transportation of liquid oxygen.
9. Enumerate the safety requirements in the design of cryogenic liquid piping system.
10. Demonstrate in detail about the various application of cryogenic liquids in
    (i) Engineering (ii) Space technology.
11. Explain the following (i) First Aid for cryogenic induced injuries
    (ii) Spillage control procedure
12. Explain the applicable rules and Indian standards for cryogenic systems.

****

SYLLABUS
MODULE I (8 hrs)
Cryogens, Properties of Cryogenic Fluids like Oxygen, Nitrogen, Argon, Neon, Florin, Helium, Hydrogen; properties of cryogenic liquids, mechanical, thermal, electrical and magnetic properties of materials at cryogenic temperatures, Primary hazards, cold contact burns, asphyxiation, pressure build up and potential explosion (pressure, chemical), physical hazards, chemical hazards, hazard control measures, PPE for cryogenic handling, leak and/or fire emergency management, spillage control procedure, First aid for cryogenic induced injuries
MODULE II (8 hrs)
Safe storage and handling of cryogenic fuels: Characteristics properties and hazards of liquid hydrogen, application of inherent safety features and control measures for storage, hazards during transportation, safe transfer of cryogenic liquid fuels. Hydrogen fire hazards, detection and control measures Hydrogen gas evolution control, thermal contraction of materials, material properties at low temperature and metals effected by embrittlement
MODULE III (9 hrs)
Safe storage and handling of cryogenic oxygen: Characteristics properties and hazards of liquid oxygen, ignition mechanism and sources of ignition, oxygen purity and cleaning safety requirements, application of inherent safety features and control measures for storage, hazards during transportation, oxygen enriched atmosphere hazards and control measures ,tank fire dangers ,safe working distances, explosive and flammability hazards of cryogenics, personnel and operational awareness
MODULE IV (8 hrs)
Design of cryogenic vessels and safety aspects: Major components of the vessel, applicable design codes, design Capacity calculations, compatible materials for cryogenic applications, hydrogen embrittlement, analytical methods for vent line and relief valve sizing, Cryogenic liquid piping system design safety requirements, design safety aspects of dewars, applicable rules and Indian standards for cryogenic systems.
MODULE V (7 hrs)
Cryo-Disasters, drinking LN2, LN2 Dewar at Texas, Challenger disaster, Appolo near disaster, Columbia Disaster,Vostok disaster, X-33 space plane, CO_2, nursing home gas mix, LPG, hydrogen bomb, materials suitable for cryogenic system and reduce safety risks, cryogenic storage and cooling systems-prevention of possibility of fires in cryogenic operations Application of cryogenic liquids in engineering, space technology, space simulation tests, nuclear research, food processing, medicine etc. .

Course Plan

No	Topic	No. of Lectures
1	**MODULE I (8 hrs)**	
1.1	Cryogens, Properties of Cryogenic Fluids like Oxygen, Nitrogen, Argon, Neon, Florin, Helium, Hydrogen; properties of cryogenic liquids, mechanical, thermal, electrical and magnetic properties of materials at cryogenic temperatures	2
1.2	Primary hazards, cold contact burns, asphyxiation, pressure build up and potential explosion (pressure, chemical)	1
1.3	Physical hazards, chemical hazards, hazard control measures, PPE for cryogenic handling ,leak and/or fire emergency management,	3
1.4	Spillage control procedure, First aid for cryogenic induced injuries	2
2	**MODULE II (8 hrs)**	
2.1	Safe storage and handling of cryogenic fuels: Characteristics properties and hazards of liquid hydrogen,	2
2.2	Ignition mechanism and sources of ignition, oxygen purity and cleaning safety requirements	1
2.3	Hazards during transportation , safe transfer of cryogenic liquid fuels.	2
2.4	Hydrogen fire hazards, detection and control measures Hydrogen gas evolution control,	2
2.5	Thermal contraction of materials, material properties at low temperature and metals effected by embrittlement	1
3	**MODULE III (9 hrs)**	
3.1	Safe storage and handling of cryogenic oxygen: Characteristics properties and hazards of liquid oxygen	2
3.2	Application of inherent safety features and control measures for storage	3
3.3	Hazards during transportation, oxygen enriched atmosphere hazards and control measures	2
3.4	Tank fire dangers ,safe working distances, explosive and flammability hazards of cryogenics, personnel and operational awareness,	2
4	**MODULE IV (8 hrs)**	
4.1	Use of portable electrical tools, drills, grinding tools, manual handling scaffolding, hoisting cranes	2
4.2	Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - builder's hoist, winches, chain pulley blocks	2
4.3	Use of conveyors and mobile cranes – manual handling	1
4.4	Use of conveyors - concrete mixers, concrete vibrators – safety in earth moving equipment, excavators, dozers, loaders, dumpers, motor grader, concrete pumps, welding machines	3
5	**MODULE V (7 hrs)**	

5.1	Cryo-Disasters, drinking LN2, LN2 Dewar at Texas, Challenger disaster, Appolo near disaster, Columbia Disaster,Vostok disaster, X-33 space plane, CO2, nursing home gas mix, LPG, hydrogen bomb	2
5.2	Cryogenic storage and cooling systems-prevention of possibility of fires in cryogenic operations	2
5.3	Materials suitable for cryogenic system and reduce safety risks	1
5.4	Application of cryogenic liquids in engineering, space technology, space simulation tests, nuclear research, food processing, medicine etc. .	2

References

1. BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1. ASME.

2. Edeskuty, F. J., & Stewart, W. F. Safety in the Handling of Cryogenic Fluids. New York: Springer.

3. NASA Safety Standards for Oxygen and Oxygen systems- Guidelines for Oxygen System Design, materials selection, Operations, Storage and Transportation. NASA NSS 1740.15.

4.Peterson, T. J., & Weisend, J. G. Cryogenic Safety - A guide to best pracice in Lab and Work Place. Springer.

5.Safety Standard for Hydrogen and Hydrogen Systems-Guidelines for Hudrogen System Design, Material Selection, Operations, Storage and Transportation. NASA NSS 1740.16.

6.Zabetakis, M. G. Safety with Cryogenic Fluids. Springer.

221ECH111	SAFETY IN CONSTRUCTION	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: The aim of this course is to know causes of accidents related to construction activities and human factors associated with these accidents and to understand the construction regulations and quality assurance in construction

Course Outcomes: After the completion of the course the student will be able to

CO 1	To identify the types and causes of accidents and designing aids for safe construction.
CO 2	To understand the hazards during construction of power plant, road works and high rise buildings.
CO 3	To understand the safety procedure for working at heights during construction
CO 4	To have knowledge in selection, operation, inspection and testing of various construction machinery.
CO 5	To understand the standards and hazards in demolition work

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1					3	1	
CO 2						2	
CO 3						2	
CO 4					2		3
CO 5					1	2	2

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyse	40
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10

publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry
7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECH111

Max. Marks: 60 Duration: 150 minutes

SAFETY IN CONSTRUCTION

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Explain the problems in safety in construction industry.
2. State any four safety arrangements in work over water.
3. Suggest any two points on safe use of ladder.
4. State the uses of conveyors.
5. List out the issues associated with demolition.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Write a short note on (i) Pre Contract Activities (ii) Pre Construction Meeting.
7. List out the safety precautions to be considered while making scaffolding.
8. Explain the requirements for working at heights as per OSHA.
9. Outline the functions of conveyors and explain its types.
10. Explain the following (i) First Aid in construction site. (ii) Fire Hazards in site.
11. Demonstrate in detail about classification of safety belts.
12. Enumerate safety in construction of Power plants.

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SYLLABUS
MODULE I (8 hrs)
ACCIDENTS CAUSES AND MANAGEMENT SYSTEMS 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
MODULE II (8 hrs)
HAZARDS OF CONSTRUCTION AND PREVENTION 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.
MODULE III (9 hrs)
WORKING AT HEIGHTS 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
MODULE IV (8 hrs)
CONSTRUCTION MACHINERY 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
MODULE V (7 hrs)
SAFETY IN DEMOLITION WORK 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.

Course Plan

No	Topic	No. of Lectures
1	**MODULE I (8 hrs)**	
1.1	Problems impeding safety in construction industry- causes of fatal accidents	2
1.2	Types and causes of accidents related to various construction activities, human factors associated with these accident	1
1.3	Pre contract activates, preconstruction meeting - design aids for safe construction – permits to work – quality assurance in construction – compensation	3
1.4	Recording of accidents and safety measures – Education and training	2
2	**MODULE II (8 hrs)**	
2.1	Excavations, basement and wide excavation, trenches, shafts – scaffoldings	2
2.2	Types, causes of accidents, scaffold inspection checklist– false work	1
2.3	Erection of structural frame work, dismantling – tunneling – blasting, pre blast and post blast inspection	2
2.4	Confined spaces – working on contaminated sites – work over water - road works	2
2.5	Power plant constructions – construction of high rise buildings.	1
3	**MODULE III (9 hrs)**	
3.1	Fall protection in construction OSHA 3146 – OSHA requirement for working at heights	2
3.2	Safe access and egress – safe use of ladders-Scaffoldings , requirement for safe work platforms, stairways, gangways and ramps	3
3.3	Fall prevention and fall protection , safety belts, safety nets, fall arrestors, controlled access zones	2
3.4	Safety monitoring systems – working on fragile roofs, work permit systems, height pass – accident case studies.	2
4	**MODULE IV (8 hrs)**	
4.1	Use of portable electrical tools, drills, grinding tools, manual handling scaffolding, hoisting cranes	2
4.2	Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - builder's hoist, winches, chain pulley blocks	2
4.3	Use of conveyors and mobile cranes – manual handling	1
4.4	Use of conveyors - concrete mixers, concrete vibrators – safety in earth moving equipment, excavators, dozers, loaders, dumpers, motor grader, concrete pumps, welding machines	3
5	**MODULE V (7 hrs)**	
5.1	Safety in demolition work, manual, mechanical, using explosive	2

5.2	Keys to safe demolition, pre survey inspection, method statement, site supervision, safe clearance zone, health hazards from demolition	2
5.3	Indian standard - trusses, girders and beams	1
5.4	Fire hazards and preventing methods	1
5.5	Interesting experiences at the construction site against the fire accidents.	1

Reference Books

1. Handbook of OSHA Construction safety and health charles D. Reese and James V. Edison

2. Hudson, R.,"Construction hazard and Safety Hand book, Butter Worth's, 1985.

3. Jnathea D.Sime, "Safety in the Build Environment", London, 1988.

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

221ECH102	HUMAN FACTORS ENGINEERING	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

This course is to introduce the basic concepts and the important issues (related to theory and application) in ergonomics and human factors engineering for work system performance and product design improvement, and the use of these concepts and technologies to select jobs and situations in industries.

Course Outcomes: After the completion of the course, the student will be able to

CO 1	Explain and apply human factors engineering concepts in both evaluation of existing systems and the design of new systems.
CO 2	Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.
CO 3	Analyze and calculate the level of risk in a job causing stress, fatigue, and musculoskeletal disorders and design appropriate work systems.
CO 4	Define and apply the principles of work design, motion economy, and work environment design.
CO 5	Recognize human capabilities and limitations and make ergonomic assessments in various workplaces.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1		1		2		1	
CO 2				2	1		
CO 3				2		1	
CO 4				2		2	
CO 5		1		2			1

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyze	40
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer-reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course-based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include a minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end-semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem-solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end-semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %. The total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECH102

Max. Marks: 60 Duration: 150 minutes

HUMAN FACTORS ENGINEERING

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question. (5x 5 = 25)

1. Explain in brief, with suitable examples concepts of (i) FMJ (ii) FJM, and (iii) Optimized ergonomic design.
2. Describe the preventive measures you may undertake for the management of industrial noise exposure. Explain the effects of prolonged noise exposure to a person.
3. State and explain in detail the 'thermal balance equation' of the human body.
4. State and explain the typical ergonomics-related design problems that a present-day operator may be facing in VDT workstations.
5. State and explain the human factors principles that are applicable in DHA.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Illustrate and explain the model of human information processing.
7. Explain the process of muscle metabolism in human beings during work.
8. Ignorance of anthropometric data and ergonomics principles in designing a product/system will lead to poor and/or hazardous design. Justify the statement with suitable examples.
9. Explain the importance of illumination in designing an effective workspace.
10. List the symptoms of heat stress. Explain the two major processes of adapting to a hot environment.
11. List your recommendations to design a computer workstation keeping principles of motion economy in view. Justify your recommendations suitably.
12. Explain why DHA is more relevant for the ergonomic improvement of product design than DFA or DFM in the present industrial situation. Cite a few examples to justify your views.

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SYLLABUS
MODULE I (8 hrs)
Introduction to Human Factors and Ergonomics: Definition, purpose, and development of human factors and ergonomics; types and components of work systems, their interactions, and evaluations; human components, machine components, and environmental components of work systems; modern work systems, FMJ vs FJM; contribution of human factors in systems design, engineering, and management. Anthropometry in Workstation Design: anthropometry in product/process design, MHD, anthropometric design motto; types of anthropometric data, principles of applied anthropometry; working posture analysis, postural triangle, design for seated and standing workers
MODULE II (8 hrs)
Physiology, Workload, and Physical Work Capacity: Metabolism during work, aerobic and anaerobic work, oxygen uptake; physical work capacity and energy expenditure, individual differences, RWL, MOW; EE of various operations in agriculture, construction, and manufacturing industry Design of Manual Material Handling Tasks: types of injury problems in manual handling tasks, types of activities, and body movements; definitions and standards of lifting: NIOSH lifting equation; EC guidelines, UK health, and safety commission guidelines; use of material handling aids, types of material handling devices.
MODULE III (8 hrs)
Ergonomic Design of Computer Workstations: ergonomic problems in computer workstations, design elements of computer workstations; specifications of computer workstation design elements; methods to reduce glare/reflection on the screen; design of human-computer interaction. Industrial Application: Work Posture for Tasks, Hand Tool Design: work postures and related complaints, work postures for different tasks, task analysis; work posture assessment, rapid entire body assessment (REBA), MSDS/RMIS; hand tool design: fitting the task, user and hand, usage of hand tools and types of injuries and their prevention
MODULE IV (9 hrs)
Measurement and Evaluation of Physical Environment - Visual Environment: Environment Component in Work systems, Ergonomic Design of Physical Environment: Basic Issues; Issues and Framework Importance of illumination system and visual environment; Measurement of illuminance, luminance, and contrast; Measures of Contrast, Contrast Ratio under Different Work Situations. Measurement and Evaluation of Physical Environment - Thermal Environment & Vibratory Environment: Problem of Heat Stress at Workplaces, Thermoregulation Process, Acclimation, and Acclimatization; Thermal Balance Equation and Heat Stress; Quality of Thermal Environment, Evaluation of Thermal Environment; whole body vibration and sources of vibration discomfort. Measurement and Evaluation of Physical Environment - Auditory Environment: Auditory Environment and Human Performance, Measurement of Sound and Noise Exposure;

Exposure to Noise and Hearing Loss Noise Analysis and Noise Reduction using Engineering Measures at Manufacturing Plants; Octave bands, Calculation of octave bands; ergonomic design of auditory environment in different workplaces.
MODULE V (7 hrs)
Ergonomic Design for Manufacturing and Assembly: Design for Manufacturing (DFM), Design for Assembly (DHA), Design for Automation (DFA) and their application; Ergonomic Design Principles, Product Design Assessment, and Improvement Measures, Maintenance in Manufacturing/Production Systems – Important Ergonomic Design Issues. Human Factors Principles and Design of Shift Work: Definition of Shift Work, Problems with Shift Work, Effect on Circadian Rhythms; Problems of Shift Workers, Shift Work, and Human Performance; Recommended shift work schedules; major ergonomic issues and problems in shift work design. Ergonomic Performance of Work systems: Concepts of ergonomic performance and its indicators.

Course Plan

No	Topic	No. of Lectures
1	**MODULE I (8 hrs)**	
1.1	Definition, purpose, and development of human factors and ergonomics	1
1.2	types and components of work systems, their interactions, and evaluations	1
1.3	human components, machine components, and environmental components of work systems; modern work systems, FMJ vs FJM	1
1.4	contribution of human factors in systems design, engineering, and management.	1
1.5	anthropometry in product/process design, MHD, anthropometric design motto;	1
1.6	types of anthropometric data, principles of applied anthropometry;	1
1.7	working posture analysis, postural triangle, design for seated and standing workers	2
2	**MODULE II (8 hrs)**	
2.1	Metabolism during work, aerobic and anaerobic work, oxygen uptake	1
2.2	physical work capacity and energy expenditure, individual differences, RWL, MOW	1
2.3	EE of various operations in the agriculture, construction, and manufacturing industry	2
2.4	types of injury problems in manual handling tasks, types of activities, and body movements;	1
2.5	definitions and standards of lifting: NIOSH lifting equation;	1
2.6	EC guidelines, UK health, and safety commission guidelines;	1
2.7	use of material handling aids, and types of material handling devices.	1
3	**MODULE III (8 hrs)**	

3.1	ergonomic problems in computer workstations, design elements of computer workstations	1
3.2	specifications of computer workstation design elements	1
3.3	methods to reduce glare/reflection on the screen	1
3.4	design of human-computer interaction.	1
3.5	work postures and related complaints, work postures for different tasks, task analysis	1
3.6	work posture assessment, rapid entire body assessment (REBA), MSDS/RMIS	1
3.7	hand tool design: fitting the task, user and hand, usage of hand tools and types of injuries and their prevention	2
4	**MODULE IV (9 hrs)**	
4.1	Environment Component in Work systems, Ergonomic Design of Physical Environment: Basic Issues and Framework	1
4.2	Importance of illumination system and visual environment, Measurement of illuminance, luminance, and contrast	1
4.3	Measures of Contrast, Contrast Ratio under Different Work Situations.	1
4.4	Problem of Heat Stress at Workplaces, Thermoregulation Process, Acclimation, and Acclimatization	1
4.5	Thermal Balance Equation and Heat Stress; Quality of Thermal Environment, Evaluation of Thermal Environment	1
4.6	whole body vibration and sources of vibration discomfort.	1
4.7	Auditory Environment and Human Performance, Measurement of Sound and Noise Exposure	1
4.8	Exposure to Noise and Hearing Loss Noise Analysis and Noise Reduction using Engineering Measures at Manufacturing Plants	1
4.9	Octave bands, Calculation of octave bands; ergonomic design of auditory environment in different workplaces	1
5	**MODULE V (7 hrs)**	
5.1	Design for Manufacturing (DFM), Design for Assembly (DHA), Design for Automation (DFA) and their application;	1
5.2	Ergonomic Design Principles, Product Design Assessment, and Improvement Measures, Maintenance in Manufacturing/Production Systems – Important Ergonomic Design Issues.	1
5.3	Definition of Shift Work, Problems with Shift Work, Effect on Circadian Rhythms;	1
5.4	Problems of Shift Workers, Shift Work and Human Performance;	1
5.5	Recommended shift work schedules; major ergonomic issues and problems in shift work design.	2
5.6	Concepts of ergonomic performance and its indicators	1

Reference Books

1. Sanders, M. S. and McCormick, E. J., Human Factors in Engineering and Design, McGraw-Hill, Sixth Edition
2. Bridger, R. S., Introduction to Ergonomics, Taylor and Francis Group, Third Edition
3. Halander M, A Guide to Human Factors and Ergonomics, Taylor and Francis Group, Second Edition.
4. Marvin E, Mundel & David L, "Motion & Time Study: Improving Productivity", Pearson Education,2000.
5. Benjamin E Niebel and Freivalds Andris, "Methods Standards & Work Design", Mc Graw Hill, 1997.

221ECH104	FOOD SAFETY MANAGEMENT SYSTEMS & SANITATIONS	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

Aim of the course is to understand the basic purpose of Food Safety Management Systems – to ensure the manufacture, storage, distribution and sale of safe food.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand about the important parameters of food safety systems.
CO 2	Acquire knowledge about safety and quality aspects in food industry and their control systems
CO 3	Understand about Hazard Analysis Critical Control Points and Biosafety levels.
CO 4	Gain knowledge on sanitation techniques and its importance in food industry.
CO 5	Understand about the national and international food standards and specifications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			1			3	
CO 2			1	1			
CO 3			1		2		
CO 4			1				
CO 5			1	1			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry
7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECH104

Max. Marks: 60 Duration: 150 minutes

FOOD SAFETY MANAGEMENT SYSTEMS & SANITATIONS

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question. (5x 5 = 25)

1. List out and explain any five GMP guidelines.
2. Classify and explain food contamination with suitable examples.
3. Describe the importance of SSOP in food industry and list out the parameters to be included in an individual SSOP.
4. Differentiate GMO and LMO with suitable examples.
5. Explain the purpose of Codex Alimentarius commission.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. "Food can become contaminated with phthalates". Substantiate this statement by clearly mentioning the occurrence and sources of phthalate contamination. Also mention the control options.
7. Explain the working of a Food Safety and Management System.
8. Enumerate and explain the different equipment maintenance program in food industry.
9. Describe how safe food can be produced by implying HACCP concept.
10. Distinguish between different Biosafety levels.
11. Explain the major steps in hazard analysis according to codex Alimentarius.
12. Give an account of the PFA, FPA and Agmark standards.

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SYLLABUS
MODULE I (8 hrs)
Principles of food safety - Historical developments, Food safety testing, National and international food regulatory agencies, General food laws and food safety regulations, Nutritional labeling regulation (mandatory and optional nutrients, nutritional descriptors and approved health claims); Microbial contamination (including cross contamination/indirect contamination) Chemical contamination, Physical contamination, Allergen contamination.
MODULE II (7 hrs)
Food Safety Programs: Good Manufacturing Practices (GMPs), Good Hygienic Practices, PRP in the food industry , Pest Control Program, Facility Maintenance, Personal Hygiene, Supplier Control, Sanitary Design of Equipment and Infrastructure, Procedures for Raw Material Reception, Storage and Finished Product Loading, Sanitation Program. (Sanitation Standard Operating Procedures (SSOPs)., Product Identification, Tracking and Recalling Program, Preventive Equipment Maintenance Program, Education and Training Program.
MODULE III (9 hrs)
Total quality management-Hazard analysis, critical control points (HACCP) and its developments- HACCP – History definition - preliminary task - principles - hazard analysis - record keeping - HACCP implementation and maintenance. General principle of microbial risk - assessment – hazard determination - HACCP worksheet. Critical Control Point. Biosafety levels BSL1, BSL2, BSL3, BSL4. Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC.
MODULE IV (8 hrs)
Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection - indicators of risk - risk analysis – risk management - causes of major failure - clothing and personal hygiene - source of contamination -test for food safety. in the food processing industry Risk classification.
MODULE V (8 hrs)
Food standards and Specifications: Food Safety and Standard Authority of India regulations - Agricultural and Processed food Export Development Authority - Marine Product Export Development Authority - Export Inspection council and Export Inspection Agency. Relevant Food laws : PFA, FPO, SWMA, MPO, AgMark, and BIS Standards. The role of IUPAC, ISO, IDF- The EFSIS Standard for Companies Supplying Food Products FAO in India, Codex Alimentarius Commission - Codex India , Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India.

Course Plan

No	Topic	No. of Lectures
1	**MODULE I (8 hrs)**	
1.1	Principles of food safety - Historical developments, Food safety testing, National and international food regulatory agencies, General food laws and food safety regulations	3
1.2	Nutritional labeling regulation (mandatory and optional nutrients, nutritional descriptors and approved health claims)	2
1.3	Microbial contamination (including cross contamination/indirect contamination)	1
1.4	Chemical contamination, Physical contamination, Allergen contamination.	2
2	**MODULE II (7 hrs)**	
2.1	Food Safety Programs: Good Manufacturing Practices (GMPs), Good Hygienic Practices, PRP in the food industry , .	2
2.2	Pest Control Program, Facility Maintenance, Personal Hygiene, Supplier Control, Sanitary Design of Equipment and Infrastructure,	2
2.3	Procedures for Raw Material Reception, Storage and Finished Product Loading,	1
2.4	Sanitation Program. (Sanitation Standard Operating Procedures (SSOPs)., Product Identification, Tracking and Recalling Program, Preventive Equipment Maintenance Program, Education and Training Program	2
3	**MODULE III (9 hrs)**	
3.1	Total quality management-Hazard analysis, critical control points (HACCP) and its developments- HACCP – History definition - preliminary task - principles - hazard analysis - record keeping - HACCP implementation and maintenance.	3
3.2	General principle of microbial risk - assessment – hazard determination - HACCP worksheet. Critical Control Point.	2
3.3	Biosafety levels BSL1,BSL2,BSL3,BSL4. Biosafety Levels of Specific Microorganisms, Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India;	2
3.4	Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC.	2
4	**MODULE IV (8 hrs)**	
4.1	Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials.	2
4.2	Control of rats, rodents, mice, birds, insects and microbes	2
4.3	Cleaning and Disinfection - indicators of risk - risk analysis – risk management - causes of major failure - clothing and personal hygiene	2
4.4	Source of contamination -test for food safety. in the food processing industry Risk classification.	2

5	**MODULE V (8 hrs)**	
5.1	Food standards and Specifications: Food Safety and Standard Authority of India regulations - Agricultural and Processed food Export Development Authority - Marine Product Export Development Authority - Export Inspection council and Export Inspection Agency.	2
5.2	Relevant Food laws : PFA, FPO, SWMA, MPO, AgMark, and BIS Standards.	2
5.3	The role of IUPAC, ISO, IDF- The EFSIS Standard for Companies Supplying Food Products FAO in India.	2
5.4	Codex Alimentarius Commission - Codex India , Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India.	2

Reference Books

1. Roday, S. 1998. Food Hygiene and Sanitation, Tata McGraw-Hill Education
2. Neal D. Fortin. 2009. Food regulation, Wiley Publishers.
3. Naomi Rees. David Watson. 2000. International standards for food safety, An Aspen Publications.

221ECH106	DESIGN OF POLLUTION CONTROL SYSTEMS	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: This course is to familiarise the environmental pollution control systems adopted in various sectors such as domestic, industrial and municipal waste management aspects. Students will be able to design suitable pollution control systems to impart at various sectors listed above for the pollution mitigation and development of sustainable life system.

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Apply suitable regulatory regimes and its amendments implemented for prevention, control and mitigate different type pollution in the environment
CO 2	Suggest and design suitable wastewater treatment system for various sectors
CO 3	Suggest and design suitable air pollution control system for various sectors
CO 4	Suggest and design appropriate hazardous waste treatment system for various sectors
CO 5	Suggest and design suitable noise pollution control system for various sectors

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1		3					
CO 2	3			3	2	3	
CO 3	3			3	3	3	
CO 4	3			3		3	
CO 5	3	3		3		3	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyse	40
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECH106

Max. Marks: 60 Duration: 150 minutes

DESIGN OF POLLUTION CONTROL SYSTEMS

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Define biosphere. Explain the salient features of Hazardous waste management rule 2016.
2. Write the design features of a horizontal flow sedimentation tank in primary wastewater treatment system.
3. Explain the leachate and gas collection and treatment methods in secured land fill process.
4. Compare dry and wet techniques to prevent particulate dust emission from an industry.
5. Explain the sources of noise pollution and its impact on workers in an industry.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Write the powers defined in Water and Air Act for prevention and control of pollution in environment.
7. Determine the aeration tank volume required for a conventional activated sludge plant to treat a daily average flow rate of 3.5 MGD, with primary effluent BOD estimated to be 175 mg/L. The design criterion is to be a volumetric loading rate of 30 lb BOD/day/1000 ft^3.
8. Write the design features of a landfill treatment system with suitable assumptions.
9. Design electrostatic precipitator to achieve an efficiency of 99%. Given airflow Q = 2,000 m^3/min Particle diameter dp = 1 μm, average particle charge q = 10 electron charges, Electric field E = 50,000 V/m Each plate has dimensions 6 m × 3 m.
10. Noise in an area measures 90 dBA for 2 hr a day, 97 dBA for 2 hr a day, and for the remaining 4 hr there are alternate noise levels of 95 dBA for 10 min and of 80 dBA for 10 min. Does this exposure exceed the permissible limit?
11. A hydrochloric acid mist in air at 25 °C is to be collected in a gravity settler. Calculate the smallest mist droplet (spherical in shape) that will always be collected by the settler. Assume the acid concentration to be uniform through the inlet cross section of the unit and Stokes' law applies. Operating data and information on the gravity settler are given below. Dimensions of gravity settler = 30 ft wide, 20 ft high, 50 ft long Actual volumetric flow rate of acidic gas = 50 ft^3 /s, Specific gravity of acid =1.6, Viscosity of air = 0.0185 cP = 1.243 x 10-5 lb/(ft.s) ,Density of air = 0.076 lb/ft^3.
12. Write the design features of a Biomedical Incinerator along with its sketch.

SYLLABUS
MODULE I: Pollution types, sources, and regulations (8 hrs)
Biosphere-Pollution-Sources-Impact on biosphere-Air, water, land and noise prevention and control of pollution regulations, act and amendments, Solid and Hazardous waste management regulations, act and amendments.
MODULE II: Design of Wastewater Treatment Systems (8 hrs)
Design of Primary, secondary and tertiary treatment systems: Primary sedimentation tank, Design of Activated Sludge Process, Design of Sludge Digester, Design of Adsorption Column, Design of Membrane Separation Process.
MODULE III: Design of Solid and Hazardous Waste Disposal Systems (8 hrs)
Municipal Solid waste collection, dumping-Design of Land fill system-Leachate and Gas Collection and Treatment, Design of Composting system. Hazardous Waste treatment: Hazardous Waste Management rule, treatment systems-Design of suitable incineration system, emission control system.
MODULE IV: Design of Air Pollution Control Systems (8 hrs)
Design and economics of Gaseous and Particulate emission control system: Dry techniques industrial dust collectors, cyclone and multiclone separators, bag filters, electrostatic precipitators, relative merits and demerits, choice of equipments. Wet techniques wet dust collection, wet cyclone, empty scrubber, column (packed) scrubber, venturi scrubber, suitability, merits and demerits. Design of Specific Gaseous Pollution Control systems: Cleaning of Gaseous effluents like sulphur dioxide, nitrogen oxides in combustion products - Control of release of carbon monoxide and hydrocarbons to the atmosphere.
MODULE V: Design of Noise Pollution Control systems and Remedies (8 hrs)
Environmental Noise Pollution, Principles of Environmental Noise, Environmental Noise and Health, Strategic Noise Mapping, types and sources, Evaluating Worker Exposures to Noise-Noise evaluation calculations, Noise Mitigation Approaches, Noise Control-Absorptive Materials, Sound Isolation, Active Noise Control, Design examples.

Course Plan:

No	Topic	Lectures
1	**Module-I (8 Hrs.)**	
1.1	Biosphere-Pollution-Sources-Impact on biosphere	2
1.2	The Environment (Protection) Act 1986 and Amendments	1
1.3	The Air (prevention and control of pollution) Act 1981, Amendments	1
1.4	The Water (prevention and control of pollution) Act 1974, Amendments	1
1.5	Noise Pollution control Act, amendments	1
1.6	Solid waste management rule 2006, act and amendments.	1

1.7	Hazardous waste management rule 2016	1
2	**Module-II (8 Hrs.)**	
2.1	Design Primary sedimentation tank: Circular	1
2.2	Horizontal flow sedimentation tank	1
2.3	Design of Activated Sludge Process: Aeration tank	2
2.4	Design of Activated Sludge Process: Secondary sedimentation tank	1
2.5	Design of Sludge Digester	1
2.6	Design of Adsorption Column	1
2.7	Design of Membrane Separation Process	1
3	**Module-III (8 Hrs.)**	
3.1	Municipal Solid waste collection, dumping	1
3.2	Design of Land fill system	2
3.3	Leachate and Gas Collection and Treatment	1
3.4	Design of Composting system	1
3.5	Hazardous Waste treatment: Hazardous Waste Management rule, Collection and disposal/treatment system	1
3.6	Design of suitable incineration system	1
3.7	Toxic emission control system	1
4	**Module-IV (8 Hrs.)**	
4.1	Design and economics of Gaseous and Particulate emission control system: Dry techniques industrial dust collectors, cyclone and multiclone separators	1
4.2	Design of bag filters	1
4.3	Design of electrostatic precipitators, relative merits and demerits, choice of equipment	1
4.4	Wet techniques wet dust collection, wet cyclone, empty scrubber, column (packed) scrubber	2
4.5	Venturi scrubber, suitability, merits and demerits.	1
4.6	Design of Specific Gaseous Pollution Control systems: Cleaning of Gaseous effluents like sulphur dioxide, nitrogen oxides in combustion products - Control of release of carbon monoxide and hydrocarbons to the atmosphere.	2
5	**Module-V (8 Hrs.)**	
5.1	Environmental Noise Pollution, Principles of Environmental Noise, Environmental Noise and Health	1
5.2	Strategic Noise Mapping, types and sources	1
5.3	Evaluating Worker Exposures to Noise-Noise evaluation calculations	1
5.4	Noise Mitigation Approaches, Noise Control-Absorptive Materials	1
5.5	Sound Isolation	1
5.6	Active Noise Control	1
5.7	Design examples	2

Reference Books

1. ENVIRONMENTAL LEGISLATION, WHO, US and Indian Regulatory regimes, Act and Amendments.
2. Metcalf and Eddy, Wastewater Engineering: Treatment and Resource Recovery, 5th Edition, McGraw-Hill, (2014).
3. Frank Woodard - Handbook of Water and Wastewater Treatment Technologies-Butterworth-Heinemann (2001).
4. Daniel A. Crowl, Joseph F. Louvar - Chemical Process Safety_ Fundamentals with Applications-Prentice Hall (2011).
5. Wark, K., Warner, C.F., and Davis, W.T., "*Air Pollution: Its Origin and Control*", Addison-Wesley Longman. (1998).
6. Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., "*Fundamentals of Air Pollution*", Academic Press. (2005).
7. Seinfeld, J.H., Pandis, S.N., "*Atmospheric Chemistry and Physics*", John Wiley. (2006).
8. Lodge, J.P. (Ed.), "*Methods of Air Sampling and Analysis*", CRC Press. (1988).
9. Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), "*Air Pollution: Health and Environmental Impacts*", CRC Press. (2010).
10. Kenneth C. Schifftner – "*Air Pollution Control Equipment Selection Guide*", CRC Press (2021).
11. Pichtel, John - Waste management practices_ municipal, hazardous, and industrial-CRC Press (2014).
12. Lawrence K. Wang, Norman C. Pereira, Yung-Tse Hung - Advanced Air and Noise Pollution Control_. volume 2-Humana Press (2004).

221ECH108	SAFETY IN HEALTH CARE WASTE MANAGEMENT	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

Healthcare waste (HCW) is a by-product of healthcare that includes sharps, non-sharps, blood, body parts, chemicals, pharmaceuticals, medical devices and radioactive materials. Our programme creates awareness about HCW and its management practices. You are provided an opportunity to learn about and technologies in health care waste management.

Course outcomes: After the completion of the course the student will be able to

CO 1	Classify the healthcare waste and identify the characteristics and sources
CO 2	Summarise the principals of waste management
CO 3	Outline the consequences of healthcare waste on human health
CO 4	Explain the sources of infection in hospital and suggests precaution and management
CO 5	Identify the occupational risk of health care workers and suggest safety policy

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2				2	
CO 2		3				1	
CO 3						3	
CO 4				3			
CO 5					2	3	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyse	40
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10

publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry
7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECH108

Max. Marks: 60 Duration: 150 minutes

SAFETY IN HEALTH CARE WASTE MANAGEMENT

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Describe different sources of healthcare waste ?
2. Explain the general principles for managing disposable and non-disposable healthcare waste ?
3. What are the different sources of infectious wastes in healthcare sector?
4. Explain about the different microbial agents in healthcare ?
5. What are the risks involved in the incineration of healthcare waste ?

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Describe different categories of health care waste suggested by the world health organisation and Gazette notification of India ?

7. Explaining the principle of management for the following waste:
   a) Chemical Disinfectants
   b) Waste from Dental Clinics
   c) Waste from blood banks

8. Describe the effects of chemical, biological and radiological pollutants on human health ?
9. Describe the infection control in operation theatre, laboratories and blood bank ?
10. Explain general and specific guidance and policies for healthcare occupational safety?
11. Describe the different infections in hospital and its sources ?
12. What are the different safety precaution doctors, nurses, paramedical and Waste Handlers and patient?

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SYLLABUS
MODULE I (8 hrs)
Definition of Waste, Municipal Waste, Health Care Waste, Sources of Health Care Waste, Types of Health Care Waste, Infectious and Non-infectious Waste, Hazardous Health Care Waste, Solid Health Care Waste and its Sources, Liquid Health Care Waste and its Sources, Biodegradable and Non-biodegradable Waste, Categories of Health Care Waste, Categories as Per World Health Organization, Categories as Per Gazette Notification of India
MODULE II (8 hrs)
General Principles of Waste Management, Do No Harm, Disposables versus Durables (Non-disposables), Reduce, Recycle, Reuse and Recover, Flow of Bio-medical Waste (Life Cycle Approach Pati), Principles of Managing Different Categories of Waste, Principles of Managing Sharps, Chemical Disinfectants, Waste from Dental Clinics, Waste from Laboratories and Blood Banks, Waste from Other ent Care Areas, Radioactive Waste, Expired Pharmaceuticals, Attenuated Vaccines, Principles of Accident Reporting, Occupational Hazards Due to Health Care Waste, Principles of Segregation, Collection, Transportation and Disposal of Health Care Waste
MODULE III (8 hrs)
Effects of Physical Pollutants, Environmental and Health Risk Associated with Medical Waste, Effects of Chemical Pollutants, Effects of Biological Pollutants, Effects of Radiological Pollutants, Sources of Infectious Agents in Health Care Waste, Infectious Waste Categories, Various Organisms in Health Care Waste, Proliferation and Desiccation, Hospital Acquired Infection, High-risk Areas and Risk Groups, Health Care Waste, Susceptibility, Risk and Impact of Health Care Waste on Health Providers, Risk Susceptibility from Hospital Waste, Categories of the Persons Exposed to Risk of Infections, Risks Associated with Infectious Wastes
MODULE IV (8 hrs)
Infection in Hospitals, Sources of Infection, Types of Microbial Agents in Hospital, Hospital Acquired Infection, Susceptible Groups, Principles of Infection Control, Hospital Infection Control Guidance Care for Patients with Probable SARS, Infection Control Precautions in Different Areas within the Health Care Facility, Operation Theatre, Wards, Laboratories, Blood Banks, Precautions while Handling Sharps, Precautions in Transportation, Precautions while Handling Spillage and Gas Waste, Accident Reporting, Post Exposure Prophylaxis
MODULE V (8 hrs)
Occupational Risks to Waste Workers, General Risks of Health Care Waste, Risk of Incineration of Health Care Waste, Risks Beyond the Health Care Settings or "Downstream" Risks, Health and Injury Issues, Environmental Health and Injury Issues, Steps for Improving Occupational Safety, Developing Hospital Safety and Health Programmes, Guidance and Policy, General Guidance and Policy, Specific Guidance and Policy, Safety Precautions for Doctors, Nurses, Paramedical and Waste Handlers, Patient Safety, World Alliance for Patient Safety, Model Injection Centre (MIC).

Course Plan

No	Topic	No. of Lectures
1	**Classification and Sources of healthcare waste (8hrs)**	
1.1	Definition of Waste, Municipal Waste, Health Care Waste, Sources of Health Care Waste, Types of Health Care Waste, Infectious and Non-infectious Waste, Hazardous Health Care Waste	3
1.2	Solid Health Care Waste and its Sources, Liquid Health Care Waste and its Sources, Biodegradable and Non-biodegradable Waste,	2
1.3	Categories of Health Care Waste, Categories as Per World Health Organization, Categories as Per Gazette Notification of India	3
2	**Principles of waste management (8hrs)**	
2.1	General Principles of Waste Management, Do No Harm, Disposables versus Durables (Non-disposables), Reduce, Recycle, Reuse and Recover, Flow of Bio-medical Waste (Life Cycle Approach),	2
2.2	Principles of Managing Different Categories of Waste, Principles of Managing Sharps, Chemical Disinfectants, Waste from Dental Clinics, Waste from Laboratories and Blood Banks, Waste from Other ent Care Areas, Radioactive Waste, Expired Pharmaceuticals, Attenuated Vaccines	4
2.3	Principles of Accident Reporting, Occupational Hazards Due to Health Care Waste, Principles of Segregation, Collection, Transportation and Disposal of Health Care Waste	2
3	**Impact of healthcare waste on human (8hrs)**	
3.1	Effects of Physical Pollutants, Environmental and Health Risk Associated with Medical Waste, Effects of Chemical Pollutants, Effects of Biological Pollutants, Effects of Radiological	2
3.2	Sources of Infectious Agents in Health Care Waste, Infectious Waste Categories, Various Organisms in Health Care Waste, Proliferation and Desiccation, Hospital Acquired Infection, High-risk Areas and Risk Groups, Health Care Waste, Susceptibility,	3
3.3	Risk and Impact of Health Care Waste on Health Providers, Risk Susceptibility from Hospital Waste, Categories of the Persons Exposed to Risk of Infections, Risks Associated with Infectious Wastes	3
4	**Infection control management (8hrs)**	
4.1	Infection in Hospitals, Sources of Infection, Types of Microbial Agents in Hospital, Hospital Acquired Infection	2
4.2	Principles of Infection Control, Hospital Infection Control Guidance Care for Patients with Probable SARS, Infection	3

	Control Precautions in Different Areas within the Health Care Facility, Operation Theatre, Wards, Laboratories, Blood Banks,	
4.3	Precautions while Handling Sharps, Precautions in Transportation, Precautions while Handling Spillage and Gas Waste, Accident Reporting, Post Exposure Prophylaxis	3
5	**Risk associated with the healthcare workers and safety(8hrs)**	
5.1	Occupational Risks to Waste Workers, General Risks of Health Care Waste, Risk of Incineration of Health Care Waste, Risks Beyond the Health Care Settings or "Downstream" Risks,	3
5.2	Occupational safety in health care system	3
5.3	Safety precaution for doctors, nurses and patients	2

Reference Book

1. Hospital Waste Management and Its Monitoring Sanskriti Sharma, Jaypee Brothers Publishers, 2002

2. https://apps.who.int/iris/bitstream/handle/10665/259491/WHO-FWC-WSH-17.05-eng.pdf

3. https://apps.who.int/iris/bitstream/handle/10665/259491/WHO-FWC-WSH-17.05-eng.pdf

221ECH110	PIPING ENGINEERING DESIGN & ANALYSIS	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

The aim of this course is to impart the knowledge about the pipelines, the components, their types and analysis in various aspects. The course also aims in familiarising the students about the knowledge about design and laying out the piping and their application in various process equipments

Course Outcomes: After the completion of the course the student will be able to

CO 1	Define various terms associated with piping engineering
CO 2	Analyse the importance and various components of piping engineering
CO 3	Apply the knowledge and Design piplines through stress analysis
CO 4	Create new piping diagrams for various equipments and plants

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1		1					
CO 2					2	1	
CO 3				3			
CO 4					2		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %. Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECH110

Max. Marks: 60 Duration: 150 minutes

PIPING ENGINEERING DESIGN & ANALYSIS

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Explain the different codes and standards available in piping. Illustrate the ASME code followed for design of piping systems in Process pipings (Refineries & Chemical Industries)?
2. Analyse the pressure drop in single phase and two phase system
3. Sketch and explain different line symbols used.
4. Analyse the different loads on pipes?
5. explain the methods used to counter corrosion?

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the ASTM code for the following?
   a. CS pipe
   b. CS fittings
   c. CS flanges
   d. AS pipe P5/P11
   e. Cast CS Valves
7. Explain any 4 types of valves with neat sketches
8. Explain steam traps? How will you classify them? What is the significance?
9. Analyse the steps involved in pipewall thickness calculation.
10. Sketch and explain the P&ID for a distillation unit.
11. Illustrate out the basic steps involved in plant design
12. Explain the steps involved in laying an underground sewer piping system?

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SYLLABUS
MODULE I (8 Hours)
Introduction to piping designing & engineering-Evolution of pipeline and Major existing Pipelines-Importance and Types Pipelines-Manufacturing methods-Piping materials and selection-Pipe dimensioning-Schedule numbers-Major organizations for standards-Codes and Standards: American Standards-ASME/ANSI, British Standards, Indian Standards
MODULE II (8 Hours)
Components of Piping- Pipes, Fittings- Type of Fittings - elbows, weld tee, stub in, couplings, reducers, weld cap, screwed and socket welded fittings, Pipe nipples, flanged fittings and use of fittings- Flange -Type of Flange, P-T ratings and facings- Gaskets, Bolting, Valves- Major Valves – Types, Functions: Isolation, Regulation, Non return, special Purpose, Materials operations, applicability, codes and specifications, Specialties
MODULE III (8 Hours)
Procedure for Sizing, Types of Flow, Pressure Drop Calculations-Single and Two phase Pipe Sizing based on available Pressure Drop, Economic Sizing, Uses of flow diagrams, process flow diagrams-mechanical flow diagrams, utility flow diagrams-piping symbols-line symbols-valve symbols-piping isometrics Plot plan procedures basics- Equipment and Piping layout- Basic Steps in Plant Design-plant utilities
MODULE IV (8 Hours)
Fundamentals of mechanical Design- Pipes under stress -Pipe wall thickness calculations-operating pressure-design pressure-operating & design temperature-max allowable operating pressure-Design of Jacketed piping Classification of loads- sustained load & occasional load. Steam Traps-Importance and Types-Selection of Pipe Supports
MODULE V (8 Hours)
Process and instrumentation diagrams -Purpose of P&ID'S-study of P&ID'S-stages of development of P&ID'S-process equipments-symbols usage according to industrial practices-Purpose of P&ID in process industrial/plants PLANT DESIGN MANAGMENET SYSTEM (PDMS) : Equipment Modeling.-Pipe Routing. Protection of Pipelines against Abrasion, Freezing and Corrosion- Lining, Coating, and Wrapping-Insulation, Tracing, Jacketing, and Electric Heating-Insulation, Tracing, Jacketing, and Electric Heating

Course Plan

No	Topic	No. of Lectures
1	**Fundamentals Of Piping (8 Hours)**	
1.1	Introduction to piping designing & engineering	2
1.2	Piping materials and selection	2
1.3	Manufacturing methods	1
1.4	Codes and Standards	3
2	**Components of Piping (8 Hours)**	
2.1	Pipes and Fittings	2
2.2	Flanges	1
2.3	Gaskets and Bolts	2
2.4	Valves	3
3	**Pipe Sizing and flow diagrams (8 Hours)**	
3.1	Types of flow and Pressure drop Calculations	2
3.2	Basics of Flow diagrams	1
3.3	Plot Procedures	2
3.4	Equipment and Piping layout	3
4	**Mechanical Design (8 Hours)**	
4.1	Fundamentals of Mechanical Design	2
4.2	Pipe design calculation	2
4.3	Classification of loads	2
4.4	Steam traps	2
5	**P&ID and PDMS (8 Hours)**	
5.1	Introduction to Process and instrumentation diagrams	3
5.2	Plant Design Management System (PDMS)	3
5.3	Protection of Pipelines	2

Reference Books

1. Henry Liu, Pipeline engineering LEWIS PUBLISHERS, 2003
2. Jack Broughton; Process utility systems; Institution of Chem. Engineers, U.K.
3. M.S. Peters and Timmerhaus, “Plant design and Economics for Chemical Engineers”, Mc Graw Hill 3rd Edition.
4. Roger Hunt and Ed Bausbacher, “Process Plant layout and Piping Design” PTR Prentice-Hall Inc

221ECH112	FUEL & COMBUSTION TECHNOLOGY	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

The aim of the course is to familiarize the students with various types of fuels and their characteristics which will help them in dealing with the safety aspects of the fuels in the present day in the industry as well as in the society. The course also aims to provide adequate knowledge in the combustion technology and their effects by familiarising the concepts of thermodynamics and kinetics of combustion

Course Outcomes: After the completion of the course the student will be able to

CO 1	Define and differentiate between various fuels
CO 2	Analyse exhaust and flue gases
CO 3	Define basic terms in combustion process
CO 4	Evaluate the combustion kinetics of any type of fuels
CO 5	Apply the knowledge of Combustion in controlling the pollutants

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1		2					
CO 2					3		
CO 3		2					
CO 4					3		
CO 5					3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyse	40
Evaluate	0
Create	0

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10

publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 221ECH112

Max. Marks: 60 Duration: 150 minutes

FUEL & COMBUSTION TECHNOLOGY

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Define and classify fuels with examples
2. Explain cracking of petroleum.
3. Discuss about gaseous fuels with examples.
4. Define combustion? Explain the mechanism involved
5. Explain the mechanism involved in Hydrocarbon Oxygen Reaction

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the processes involved in coal treatment
7. Describe the distillation process with a neat sketch
8. Explain how LPG is manufactured
9. Explain coal gasification and liquefaction
10. Analyse the different flue gas analysis methods?
11. Explain about rocket propellants and explosives.
12. a) A hydrocarbon fuel is fully combusted with 18.214 g of oxygen to yield 23.118 g of carbon dioxide and 4.729 g of water. Find the empirical formula for the hydrocarbon.

    b) After combustion with excess oxygen, a 12.501 g of a petroleum compound produced 38.196 g of carbon dioxide and 18.752 of water. A previous analysis determined that the compound does not contain oxygen. Establish the empirical formula of the compound

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SYLLABUS
MODULE I (10 Hours)
Fuels: Detailed classification – Conventional and Unconventional, Solid, Liquid, gaseous fuels and nuclear fuels - Origin and Analysis of fuels Solid fuels – Classification, preparation, cleaning, analysis, ranking and properties – action of heat, oxidation, hydrogenation, carbonization, liquefaction and gasification. Coal-Coal classification, composition and basis -Coal mining, Coal preparation and washing - Combustion of coal and coke making -Action of heat on different coal samples - Different types of coal combustion techniques - Coal tar distillation - Coal liquefaction - Direct liquefaction - Indirect liquefaction - Coal gasification
MODULE II (8 Hours)
Liquid fuels – Petroleum - origin, production, composition, classification, petroleum processing, properties, testing – flow test, smoke points, storage and handling. Secondary liquid fuels — petroleum based fuels - Gasoline, diesel, kerosene and lubricating oils. Exploration of crude petroleum-Evaluation of crude-Distillation: Atmospheric distillation, Vacuum distillation Secondary processing- Cracking: Thermal cracking, Visbreaking, Coking, Catalytic cracking-Reforming of naphtha-Hydrotreatment, dewaxing, deasphalting-Refinery equipments -ASTM methods of testing the fuels.
MODULE III (8 Hours)
Gaseous fuels – Types, natural gas, methane from coal mine, water gas, carrier gas, producer gas, flue gas, blast furnace gas, biomass gas, refinery gas, LPG – manufacture, cleaning, purification and analysis. Problems associated with very low calorific value gases: Coal Gas – Blast Furnace Gas, Alcohols and Biogas Fuels for spark ignition engines, knocking and octane number, anti-knock additives, fuels for compression, engines, octane number, fuels for jet engines and rockets. Rocket propellants and Explosives – classification, characteristics; storage and handling.
MODULE IV (6 Hours)
Combustion: Nature and types of combustion processes – Mechanism Combustion burners -Combustion furnaces -Internal combustion engines Combustion Characteristics: ignition temperature, explosion range, flash and fire points, calorific value, calorific intensity, theoretical flame temperature Heat of reaction - Calorific value –Estimation of adiabatic flame temperature – Equilibrium
MODULE V (8 Hours)
Combustion chemistry – Stoichiometry. Theoretical air requirements, flue gas analysis methods -Flue gas analysis by chromatography and sensor techniques. Chemical kinetics - Important chemical mechanisms - Simplified conservation equations for reacting flows - - Law of mass action-order and molecularity of reaction rate equation

Course Plan

No	Topic	No. of Lectures
1	**Solid Fuels (10 Hours)**	
1.1	Classification of Fuels	1
1.2	Origin and Analysis of fuels	1
1.3	Classification and characteristics of Solid fuel	1
1.4	Coal Classification and Mining	1
1.5	Coal preparation and washing	2
1.6	Combustion of coal and coke making	1
1.7	Coal liquefaction	2
1.8	Coal Gasification	1
2	**Liquid Fuels (8 Hours)**	
2.1	Introduction to Liquid fuels	1
2.2	Analysis of Liquid Fuels	1
2.3	Secondary and Petroleum based liquid fuels	2
2.4	Exploration and Evaluation of Crude	2
2.5	Secondary processessing of Crude	2
3	**Gaseous Fuels (8 Hours)**	
3.1	Classification of Gaseous fuels	2
3.2	Characteristics of LPG	1
3.3	Low Calorific Value gases	1
3.4	Characteristics of fuels for ignition	2
3.5	Rocket propellants and Explosives	2
4	**Combustion Thermodynamics (6 Hours)**	
4.1	Nature and types of combustion processes	1
4.2	Combustion Equipments	1
4.3	Characteristics of Combustion	2
4.4	Heat of combustion	2
5	**Combustion Chemistry (8 Hours)**	
5.1	Stoichiometric Calculations of Combustion	2
5.2	Flue Gas Analysis Methods	2
5.3	Kinetics of combustion	2
5.4	Combustion generated Air Pollution	2

Reference Books

1. Samir Sarkar, Fuels and Combustion, Orient Longman Pvt. Ltd, 3rd edition, 2009
2. Turns, S.R., An Introduction to Combustion - Concepts and Applications, 2nd ed., McGraw-Hill, 2000.
3. Fuels Combustion and Furnaces, John Griswold, Mc-Graw Hill Book Company Inc
4. Sharma, S.P. and Mohan, C., Fuels and Combustion, Tata McGraw-Hill, 1987.

221LCH001	INDUSTRIAL SAFETY LABORATORY - I	CATEGORY	L	T	P	CREDIT
		PCC	0	0	2	1

Preamble: The course is aimed at giving practical experience in Industrial Safety and by the way of doing experiments/study to measure parameters relevant to health, safety, environment and evaluation of occupational health hazards and control strategies to control the hazards.

Course Outcome: At the end of the course, the students will be able to

CO 1	Demonstrate exhaust gas measurement and analyze the implications
CO 2	Demonstrate fatigue level and analyze the implications on work activity
CO 3	Compute the heat stress and UV radiation from the various environments
CO 4	Compute noise and vibration level in work environment and apply suitable counter measures
CO 5	Compute dust and fume level in breathing air and conduct ambient air analysis

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3

Assessment:

Continuous Internal Evaluation: 100 marks

List of experiments:

1. Noise Level Measurement and Analysis
    a. Measurement of noise level for various sources – Impact, continuous and intermittent. Frequency and spectrum analysis of noise: *Instrument – precision type of Noise level meter with frequency and spectrum analyzer.*
2. Measurement of Heat Stress Index
    a. Determination of heat stress index using WBGT instrument in indoor and outdoor environments.
3. Measurement of Ultraviolet Radiation
    a. Determination of ultraviolet radiation during welding operation and outdoor environment
4. Measurement of Illumination Level
    a. Determination of level of illumination in various labs in the department.
5. Exhaust Gas Measurement and Analysis

    a. Measurement of Exhaust gas measurement of IC engines: *Instrument – Gas analyzer*
6. Breathing Zone Concentration
    a. Measurement of breathing zone concentration of dust and fumes: *Instrument- Personal air sampler, Measurement of particulate matters (PM 2.5, PM1, PM0.5 and PM 0.25) in the Breathing zone*
7. Ambient Air Monitoring
    a. Measurement of respirable and non-respirable dust in the ambient air: *Instrument – High volume sampler*
8. Fume Formation Rate(FFR)
    a. Measurement of fume formation rate in welding operation using Total fume chamber as per ISO 15011-1
9. Determination of Gas and Vapour
    a. Determination of gas and vapour by using air sampling instruments.
10. Vibration Measurement and Analysis
    a. Measurement of whole body vibration for various acceleration: *Instrument – vibration simulator and vibration analyzer*
11. Digital Human Modeling Software for Virtual Ergonomics Evaluation
    a. Biomechanical Analysis (Cognitive Workload and Fatigue) with EMG Instrument
12. Study of Fire Extinguishers
    a. Selection and demonstration of first-aid fire extinguishers: soda acid, foam, carbon dioxide (CO2), dry chemical powder, halon.
13. Filling of Cartridge Type Water, DCP, and Foam Based Portable Extingushers
14. Performance Test on Portable Fire Extinguisher, Water Type (Gas Cartridge)
15. Discharge Performance Test on Mechanical Foam Type Portable Fire Extinguisher
16. Determination of the Apparent Density of DCP
17. Water Repellency test on DCP
18. Determination of Specific gravity of AFFF
19. Determination of pH value of AFFF
20. Performance Test on Portable DCP Type Extinguisher (Cartridge Type

SYLLABUS

SECOND SEMESTER

222TCH201	FIRE ENGINEERING AND EXPLOSION CONTROL	CATEGORY	L	T	P	CREDIT
		PCC	3	0	0	3

Preamble:

The objective of the course is to know about the science of fire and explosion, fire fighting techniques and legal requirements regarding the same.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the concepts of fire and explosion.
CO 2	Identify the different sources of ignition and suggest suitable prevention techniques.
CO 3	Describe the operation of various types of firefighting equipment and fixed fire protection systems.
CO 4	Explain the fire safety requirements of various types of buildings.
CO 5	Design suitable sprinkler system as per standards.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3		3		
CO 2			3		3		
CO 3			3		3		
CO 4			3		3		
CO 5			3	3	3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	

Create	

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Micro project/Course based project : 20 marks
Course based task/Seminar/Quiz : 10 marks
Test paper, 1 no. : 10 marks

The project shall be done individually. Group projects not permitted. Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical/short answer questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 222TCH201

Max. Marks: 60 Duration: 150 minutes

FIRE ENGINEERING AND EXPLOSION CONTROL

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. What is fire? Explain flash fire how is it differ from jet fire.
2. What is the fire triangle and how do we use it?
3. What are the types of sprinklers?
4. List Fire-retardant materials used in buildings and also explain Fire Safety Certificate.
5. Distinguish between fire and explosion

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Describe Poly Ethylene plant explosion Pasadena case study.
7. Explain Bombay Victoria dock ship explosion case study.
8. Explain the rescue and escape systems in fire accident.
9. Write briefly about Heat and smoke detectors.
10. Explain in detail about industrial fire protecting systems.
11. Write about the Safety regulations as per NBC.
12. Discuss in detail about the following terms. (i)Deflagration (ii) Detonation (iii) Explosion Limits.

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SYLLABUS
MODULE I (7 hours)
PHYSICS AND CHEMISTRY OF FIRE Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - theory of combustion and explosion -flash point-fire point-UFL-LFL– 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, Bombay Victoria dock ship explosions, Mahul refinery explosion, Nagothane vapour cloud explosion and Vizag refinery disaster.
MODULE II (7 hours)
FIRE PREVENTION AND PROTECTION Sources of ignition – fire triangle-Fire tetrahedron – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E Types of fire extinguishers – fire stoppers – hydrant pipes – hoses – monitors – fire watchers – layout of standpipes – fire station- fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – first aid for burns. Safety requirements for Hot work activity in industries.
MODULE III (9 hours)
INDUSTRIAL FIRE PROTECTION SYSTEMS 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. Design of sprinkler system as per relevant BIS. Other suppression systems – CO_2 system, foam system, dry chemical powder (DCP) system, halon system – smoke venting. Care, inspection, and maintenance of portable extinguishers as per relevant BIS– flammable liquids – tank farms – indices of inflammability- firefighting systems.
MODULE IV (8 hours)
BUILDING FIRE SAFETY Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity The concept of Egress design - exit – width calculations - fire certificates – fire safety requirements for high rise buildings-snookers National Building Code Part 4- Fire and Life safety

MODULE V (9 hours)
EXPLOSION PROTECTING SYSTEMS Principles of explosion-detonation and blast waves-explosion parameters – Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, TNT Equivalency, 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). Static and Mobile Pressure Vessel (SMPV) rules

Course Plan

No	Topic	No. of lectures
	Module 1	
1.1	Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - theory of combustion and explosion	2
1.2	vapour clouds – flash fire – jet fires – pool fires	1
1.3	unconfined vapour cloud explosion, shock waves - auto-ignition – boiling liquid expanding vapour explosion	2
1.4	case studies – Flixborough, Mexico disaster, Pasadena Texas, Piper Alpha, Bombay Victoria dock ship explosions, Mahul refinery explosion, Nagothane vapour cloud explosion and Vizag refinery disaster.	2
	Module 2	
2.1	Sources of ignition – fire triangle-Fire tetrahedron – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E-	2
2.2	Fire extinguishing agents- Water, Foam, Dry chemical powder, Carbon-dioxide-Halon alternatives Halocarbon compounds-Free agent fire extinguisher-Inert gases, dry powders – types of fire extinguishers	2
2.3	fire stoppers – hydrant pipes – hoses – monitors – fire watchers – layout of standpipes – fire station-	1
2.4	fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – first aid for burns.	2

	Module 3	
3.1	Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards	2
3.2	alarm and detection systems.	1
3.3	Design of sprinkler system as per relevant BIS.	2
3.4	Other suppression systems – CO_2 system, foam system, dry chemical powder (DCP) system, halon system – the need for halon replacement – smoke venting.	2
3.4	Portable extinguishers – flammable liquids – tank farms – indices of inflammability- firefighting systems.	2
	Module 4	
4.1	Objectives of fire safe building design, Fire load,	2
4.2	fire resistant material and fire testing – structural fire protection – structural integrity –	2
4.3	the concept of Egress design - exit – width calculations	1
4.4	fire certificates -fire safety requirements for high rise buildings.	1
4.5	National Building Code Part 4- Fire and Life safety	2
	Module 5	
5.1	Principles of explosion-detonation and blast waves-mechanical and chemical explosion, Vapour cloud explosion-explosion parameters –	2
5.2	Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, TNT Equivalency,	2
5.3	explosion relief of large enclosure- explosion venting-inert gases, plant for generation of inert gas rupture disc in process vessels and lines explosion,	2
5.4	suppression system based on carbon dioxide (CO_2) and halons-hazards in LPG, ammonia (NH_3).	1
5.5	Static and Mobile Pressure Vessel (SMPV) rules	2

Reference Books

1. Purandare D. D & Abhay D. Purandare, “Handbook on Industrial Fire Safety” P & A publications, New Delhi, 2006.
2. Jain V K “Fire Safety in Building” New Age International 1996.
3. Derek, James, “Fire Prevention Hand Book”, Butter Worths and Company, London, 1986.
4. Arthur E Cote “Fire protection Handbook” NFPA 2008.
5. Gupta, R.S., “Hand Book of Fire Technology” Orient Blackswan, 2010.
6. McElroy, Frank E “Accident Prevention manual for industrial operations” N.S.C., Chicago, 1988.
7. Dinko Tuhtar, “Fire and explosion protection – A System Approach” Ellis Horwood Ltd, Publisher, 1989.s
8. “Firefighters hazardous materials reference book”, Van Nostrand Rein Hold, New York, 1993.
9. Dennis P. Nolan “Handbook of Fire & Explosion Protection Engineering Principles for Oil, Gas, Chemical & Related Facilities”, William Andrew Publishers, 1996.

222TCH202	Risk Analysis & Hazard Assessment	CATEGORY	L	T	P	CREDIT
		PCC	3	0	0	3

Preamble: The subject aims to impart students with knowledge and skill for hazard identification and evaluation, modelling fire, explosion and toxic gas release, measurement and calculation of risk, layer of protection analysis, and site security for chemical process industries.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply suitable techniques to identify and quantify the hazards in an industry.
CO 2	Estimate the consequences of fire, explosion and toxic gas release using suitable empirical models.
CO 3	Calculate the individual and societal risk values of a process industry.
CO 4	Perform layer of protection analysis and compute SIL of a process industry.
CO 5	Identify the various threats and vulnerabilities in process industries and devise strategies to counter attacks.
CO6	Demonstrate the use of various equipments in quantifying reactive chemical hazards

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3	3	3		
CO 2			3		3		
CO 3			3		3		
CO 4			3	3	3		
CO 5			3		3		
CO 6			3		3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Micro project/Course based project: 20 marks
Course based task/Seminar/Quiz: 10 marks
Test paper, 1 no.: 10 marks;
The project shall be done individually. Group projects not permitted.
Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical/short answer questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 222TCH202

Max. Marks: 60 Duration: 150 minutes

RISK ANALYSIS AND HAZARD ASESSMENT

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1.″A cut set comprising several components is less likely to fail than one containing single component″. Discuss.

2.Discuss any one mathematical model used for dispersion of toxic gas.

3.Differentiate between accepted and imposed risk.

4. “All IPLs are safeguards but not all safeguards are IPLs”. Justify.

5. Compare safety risk and security risk.

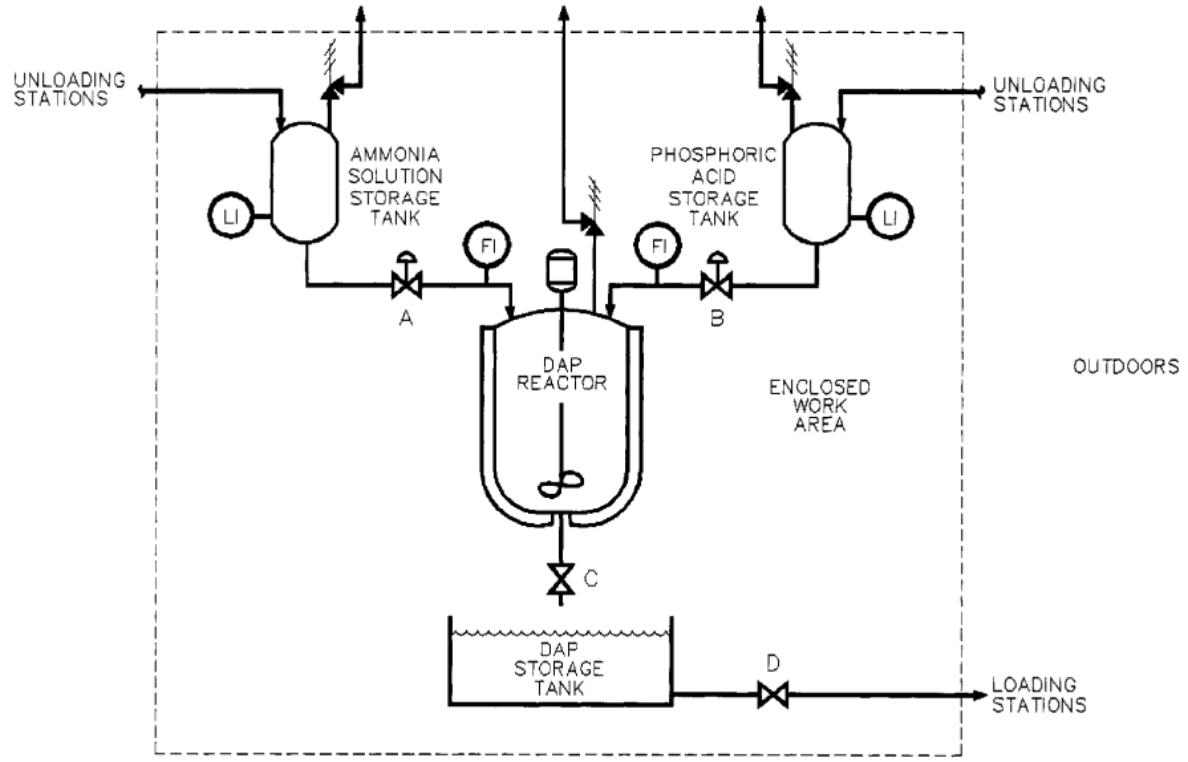
PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. A proposed continuous process is shown in Figure. In this process, a phosphoric acid solution and an ammonia solution are provided through flow control valves to an agitated reactor. The ammonia and phosphoric acid react to form diammonium phosphate (DAP), a non-hazardous product. The DAP flows from the reactor to an open-top storage tank. Relief valves are provided on the storage tanks and the reactor with discharges to outside of the enclosed work area. If too much phosphoric acid is fed to the reactor (compared to the ammonia feed rate), an off-specification product is created, but the reaction is safe. If the ammonia and phosphoric acid flow rates both increases, the rate of energy release may accelerate, and the reactor, as designed, may be unable to handle the resulting increase in temperature and pressure. If too much ammonia is fed to the reactor (as compared to the normal phosphoric acid feed rate), unreacted ammonia may carry over to the DAP storage tank. Any residual ammonia in the DAP tank will be released into the enclosed work area, causing personnel exposure. Ammonia

detectors and alarms are provided in the work area. Conduct a HAZOP study for this process considering any two nodes of your interest.



7. A storage tank contains water contaminated with a small quantity of a soluble hazardous waste material. The tank is 3 m in diameter and 6 m high. At the current time the liquid height is within 1 m of the top of the tank.

a. If a 3-cm (internal diameter) feed pipe at the bottom of the tank breaks off, what is the final liquid level (in m) if an emergency response procedure requires 30 min to stop the flow?

b. How much liquid (in m^3) is spilled?

c. What is the maximum spill rate of liquid (in kg/s)? Assume that the tank is vented. Take $C_0 = 0.61$. Density of water= 1000 Kg/m^3

8. On an overcast day a stack with an effective height of 60 m is releasing sulphur dioxide at the rate of 80 g/s. The wind speed is 6 m/s. The stack is located in a rural area. Determine

a. The mean concentration of SO_2 on the ground 500 m downwind.

b. The mean concentration on the ground 500 m downwind and 50 m crosswind.

c. The location of the maximum mean concentration on ground level directly downwind. For stability class D, Dispersion coefficients are $\sigma_y = 0.08x(1 + 0.0001x)^{0.5}$, $\sigma_z = 0.06x(1 + 0.0015x)^{-0.5}$, x is in meters.

9. A tank fill operation happens 250 times per year, could experience an overfill event 250 times per year. A proper drain system can reduce the danger by a factor of 100 (Risk reduction factor). This scenario is deemed to be intolerable by the owner, planning to reduce acceptable hazard frequency once in 10 years by adding SIF. Determine SIL level of SIF.

10. Discuss the procedure to be followed during bomb threat in a Chemical process Industry.

11. Explain various steps involved in the estimation of individual risk.

12. Discuss inductive and deductive techniques used in risk analysis with suitable examples.

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SYLLABUS

MODULE I: HAZARD EVALUATION PROCEDURES (8 hrs.)

Hazard and risk, Major industrial hazards, Non-Scenario based hazard evaluation procedures: Preliminary hazard analysis, Safety review, Relative ranking, Checklist analysis. fire explosion and toxicity index (FETI)

Scenario-Based Hazard Evaluation Procedures: What-If Analysis Hazard and Operability Studies (HAZOP), Hazard analysis (HAZAN), Fault Tree Analysis, Event Tree Analysis, Logic symbols, methodology, minimal cut set- various indices FMEA and FMECA, Bow-Tie Analysis.

Selection of Hazard Evaluation Techniques

MODULE II: CONSEQUENCE MODELLING (8 hrs.)

Source models: Flow of liquid through a hole and pipe, Flow of gases through holes, flashing liquids, Liquid pool evaporation and boiling.

Dispersion models: Factors affecting dispersion, Plume model, Puff model, Dense gas dispersion models.

Software application for effect and damage calculations: ALOHA and PHAST

MODULE III: RISK ESTIMATION (8 hrs.)

Steps in Chemical Process Quantitative risk analysis, Accepted and imposed risk, Risk perception, ALARP, Acceptance criteria for risk, Presentation of measures of risk – risk contour, F-N curve. Calculation of individual risk and Societal risk. Selection of Risk Measures and Presentation format, Risk Uncertainty and Sensitivity.

MODULE IV: LAYER OF PROTECTION ANALYSIS AND SITE SECURITY (8 hrs.)

Layer of Protection Analysis (LOPA)-LOPA methodology- LOPA team. Scenario development – components, inherently safe considerations. Initiating causes / effects – identification, estimation of frequencies. Independent protection layers – IPL criteria, allocation of IPL credit – basic process control systems, operator response, pressure relief device, safety instrumented system, safety instrumented function. Risk tolerance criteria-Safety integrity level (SIL) assignment, -Interpreting LOPA results -risk decisions and making recommendations.

Site security for process industries – Essential elements – threat analysis, Employee and Contractor Security Issues-Workplace Violence Prevention and Response. Specific security measures – information security, cyber security, physical security, policies and procedures, training, mitigation and response, inherently safer processes. Case study

MODULE V: INSTRUMENTATION (8 hrs.)
Applications of Advanced Equipments and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter (DSC), Thermo Gravimetric Analyzer (TGA), Accelerated Rate Calorimeter (ARC), 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.

Course Plan

No	Topic	No. of Lectures
	HAZARD EVALUATION PROCEDURES (8 hrs.)	
1.1	Hazard and risk, Major industrial hazards, Non-Scenario based hazard evaluation procedures: Preliminary hazard analysis, Safety review, Relative ranking, Checklist analysis. fire explosion and toxicity index (FETI)	3
1.2	Scenario-Based Hazard Evaluation Procedures: What-If Analysis Hazard and Operability Studies (HAZOP), Hazard analysis (HAZAN), Fault Tree Analysis, Event Tree Analysis, Logic symbols, methodology, minimal cut set- various indices FMEA and FMECA, Bow-Tie Analysis.	4
1.3	Selection of Hazard Evaluation Techniques	1
	CONSEQUENCE MODELLING (8 hrs.)	
2.1	Source models: Flow of liquid through a hole, Flow of liquid through a hole in a tank, Flow of liquids through pipes, Flow of gases through holes, flashing liquids, Liquid pool evaporation and boiling	3
2.2	Dispersion models: Factors affecting dispersion, Plume model, Puff model, Dense gas dispersion models.	3
2.3	Software application for effect and damage calculations: ALOHA and PHAST	2

RISK ESTIMATION (8 hrs.)		
3.1	Steps in Chemical Process Quantitative risk analysis, Accepted and imposed risk, Risk perception, ALARP, Acceptance criteria for risk	2
3.2	Presentation of measures of risk – risk contour, F-N curve. Calculation of individual risk and Societal risk.	4
3.3	Selection of Risk Measures and Presentation format, Risk Uncertainty and Sensitivity.	2
LAYER OF PROTECTION ANALYSIS AND SITE SECURITY (8 hrs.)		
4.1	Layer of Protection Analysis (LOPA)-LOPA methodology- LOPA team. Scenario development – components, inherently safe considerations. Initiating causes / effects – identification, estimation of frequencies. Independent protection layers – IPL criteria, allocation of IPL credit – basic process control systems, operator response, pressure relief device, safety instrumented system, safety instrumented function. Risk tolerance criteria-Safety integrity level (SIL) assignment, -Interpreting LOPA results -risk decisions and making recommendations.	5
4.2	Site security for process industries – Essential elements – threat analysis, Employee and Contractor Security Issues-Workplace Violence Prevention and Response. Specific security measures – information security, cyber security, physical security, policies and procedures, training, mitigation and response, inherently safer processes. Case study	3
INSTRUMENTATION (8 hrs.)		
5.1	Applications of Advanced Equipments and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter (DSC), Thermo Gravimetric Analyzer (TGA), Accelerated Rate Calorimeter (ARC), Principles of operations, Controlling parameters, Applications, advantages.	4

5.2	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.	4

Reference Books

1. Daniel A Crowl& Joseph F Louvar, Chemical Process Safety, Second Edition, Prentice-Hall.
2. Lees' Loss Prevention in Process Industries, 3rd edition, Elsevier, 2005.
3. Ian T. Cameron and Reghuraman, Process System Risk Management, Vol. 6, Elsevier Academic press, 2005.
4. G.L.Wells, Safety in process plant design, John Wiley& Sons.
5. Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions, Flash Fires, and BLEVEs. CCPS/AIChE, 1994.
6. Layer of Protection Analysis: Simplified process risk assessment. CCPS/AIChE, New York, 2001.
7. Guidelines for Chemical Process Quantitative Risk Analysis. 2nd Edition, CCPS/AIChE, New York, 2000.
8. Guideline for Hazard Evaluation Procedures. 2nd edition, CCPS/AIChE, New York,1992.
9. Trevor Kletz, Hazop and Hazan- Identifying and Assessing Process Industry Hazards, 4th Edition, Institution of Chemical Engineers, UK.

222ECH201	PROCESS MODELLING AND SIMULATION	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

In chemical engineering, modelling and simulation are important tools for engineers and scientists to better understand the behaviour of chemical plants. Modelling and simulation are very useful to design, to scale up and optimize pieces of equipment and chemical plants, for process control, for troubleshooting, for operational fault detection, for training of operators and engineers, for costing and operational planning, etc. A very important characteristic of modelling and simulation is its advantageous cost–benefit ratio because with a virtual chemical plant, obtained from the modelling and simulation, it is possible to predict different scenarios of operations and to test many layouts at almost no cost and in a safe way.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Summarize the methods and approaches used in Process Modelling and Simulation.
CO 2	Apply the fundamental laws of chemical engineering systems in developing mathematical models of process.
CO 3	Develop models for reactor systems.
CO 4	Develop models for separation processes.
CO 5	Develop models for distributed systems.
CO 6	Apply Simulation strategy for flow/reactor systems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2		2	3		2	
CO 2	2		2	3		2	
CO 3	2		2	3		2	
CO 4	2		2	3		2	
CO 5	2		2	3		2	
CO 6	2		2	3		2	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the University. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
222TCH100: PROCESS MODELLING AND SIMULATION

Max. Marks: 60 Duration: 150 minutes

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Explain modelling with an example.
2. Explain equation of chemical kinetics.
3. Write the model equation of batch reactor.
4. Write the model equation of heating in open vessel.
5. Explain distributed systems with an example.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the uses of mathematical modelling?
7. Explain the classification of modelling techniques?
8. Explain the basic modelling principles.
9. Develop the mathematical model for continuous flow tank.
10. Develop the mathematical model for steam jacketed vessel.
11. Develop the mathematical model for batch distillation.
12. Develop the simulation strategy of a gravity flow tank for the level dynamics.

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SYLLABUS

Module 1 (8 hours)
Definitions and basic concepts: Definitions and basic concepts: Definition of Modelling, Simulation, Classification of modelling techniques, Basic modelling principles, Parameter estimation techniques in theoretical as well as numerical models
Module 2 (8 hours)
Fundamental laws of chemical engineering: Fundamental laws of chemical engineering, Energy equations, continuity equation, equation of motion, transport equations, equations of state, Equilibrium states and chemical kinetics, Modeling of continuous flow tank.
Module 3 (8 hours)
Models of reactors: Models of reactors: Mixing with reaction - reversible reaction-steam jacketed vessel-isothermal constant and variable holdup CSTR in series-Boiling in open and closed vessel.
Module 4 (8 hours)
Models of separation processes: Models of separation processes: Multicomponent flash drum- ideal binary distillation column – multicomponent distillation column, batch distillation-condensation
Module 5 (8 hours)
Distributed system modelling: Distributed system modelling: Jacketed tubular reactor - counter current liquid-liquid heat exchanger, Simulation of gravity flow tank- CSTR in series - non-isothermal CSTR- batch reactor

Course plan

No	Topic	No. of Lectures
1	**Definitions and basic concepts (8 hours)**	
1.1	Definition of Modelling, Simulation,	2
1.2	Classification of modelling techniques,	2
1.3	Basic modelling principles	2
1.4	Parameter estimation techniques in theoretical as well as numerical models.	2
2	**Fundamental laws of chemical engineering (8 hours)**	
2.1	Energy equations, continuity equation,	2
2.2	Equation of motion, transport equations,	2
2.3	Equations of state, Equilibrium states and chemical kinetics,	2
2.4	Modelling of continuous flow tank	2
3	**Models of reactors (8 hours)**	
3.1	Mixing with reaction - reversible reaction	2
3.2	Steam jacketed vessel	2
3.3	Isothermal constant and variable holdup CSTR in series-	2
3.4	Boiling in open and closed vessel.	2
4	**Models of separation processes (8 hours)**	
4.1	Multicomponent flash drum, Condensation	2
4.2	Ideal binary distillation column	2
4.3	Multicomponent distillation column	2
4.4	Batch distillation	2
5	**Distributed system modelling (8 hours)**	
5.1	Jacketed tubular reactor	2
5.2	Counter current liquid-liquid heat exchanger	2
5.3	Simulation of gravity flow tank, CSTR in series	2
5.4	Simulation of non-isothermal CSTR.	2

Reference Books

1. Denn M. M., "Process Modeling", Longman, 1986.

2. Holland C. D., "Fundamentals and Modeling of Separation Processes", Prentice Hall., 1975.

3. Luyben W. L., "Process Modeling Simulation and Control for Chemical Engineers", 2nd Ed., McGraw Hill, 1990.

4. Najim K., "Process Modeling and Control in Chemical Engineering", CRC, 1990.

5. Aris R., "Mathematical Modeling, Vol. 1: A Chemical Engineering Perspective (Process System Engineering)", Academic Press, 1999.

222ECH203	DISASTER MANAGEMENT & EMERGENCY PLANNING	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

The main aim of this course to study various aspects of disaster management, mitigation measures and national policies.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Effectively define and describe the terminology used within disaster planning and emergency management.
CO 2	Discuss effective means to plan, mitigate, respond, and recover from disasters and emergencies, natural and man-made.
CO 3	Describe the emergency measures.
CO 4	Develop onsite and offsite emergency plan.
CO 5	Explain risk and disaster assessment processes including standards, and national policies.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3				
CO 2			3	1		2	
CO 3			3			2	
CO 4			3	3			
CO 5			3	3			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 222ECH203

Max. Marks: 60 Duration: 150 minutes

DISASTER MANAGEMENT & EMERGENCY PLANNING

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. State the difference between hazard and disaster
2. Explain offsite and onsite emergency plans
3. Explain the relevance and adverse effects of greenhouse gases.
4. Discuss environmental impact by onshore and offshore drilling activities.
5. Write short notes on Disaster Management Act.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Describe various factors that caused Bhopal gas tragedy.
7. Describe APELL and state its objectives and methodology.
8. Discuss effects of global warming on rise in sea level.
9. Describe offshore oil drilling and discuss its effects on marine life.
10. Discuss various clauses of Disaster Management Act, 2005.
11. Describe various components of disaster relief and discuss on disaster preparedness policies.
12. Explain Environment Impact Assessment and discuss EIA processes for an industry in India.

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SYLLABUS
MODULE I (8 hours)
INTRODUCTION Philosophy of Disaster management- Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling. Natural Disasters and Man-Made Disasters. Difference between Accidents and Disasters. 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. Chemical, biological, radiological and nuclear disasters – case studies.
MODULE II (9 hours)
ONSITE – OFFSITE EMERGENCY PLAN Mitigation versus Preparedness. Emergencies and control measures-APELL-Onsite and Offsite emergencies-Crisis management groups(National Institute of Disaster Management, National Disaster Response Force (NDRF)National Disaster Management Authority, States Disaster Management Authority, District Disaster Management Authority)-Emergency centres and their functions throughout the country-Software on emergency controls-Monitoring devices for detection of gases in the atmosphere, Early warning Systems Models in disaster preparedness. Components of Disaster Relief (Water, food, sanitation, shelter, Health and Waste Management), Community based DRR, Policies for Disaster Preparedness Programs, Preparedness Planning, Roles and Responsibilities, Public Awareness and Warnings, Rehabilitation measures and long-term reconstruction.
MODULE III (7 hours)
ENVIRONMENTAL ASSESSMENT 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 Assessment
MODULE IV (8 hours)
DISASTER ASSESSMENT 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.
MODULE V (8 hours)
EMERGENCY MEASURES Environmental education-Population and community ecology-Natural resources conservation-Environmental protection and law-Research methodology and systems analysis- Risk assessment process, assessment for different dis aster 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, Disaster Management Act-2005

Course Plan

No	Topic	No. of lectures
	Module 1	
1.1	Philosophy of Disaster management- Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness,	2
1.2	disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling. Natural Disasters and Man-Made Disasters. Difference between Accidents and Disasters.	1
1.3	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.	3
1.4	Chemical, biological, radiological and nuclear disasters – case studies.	2
	Module 2	
2.1	Mitigation versus Preparedness. Emergencies and control measures-APELL-Onsite and Offsite emergencies-	2
2.2	Crisis management groups(National Institute of Disaster Management, National Disaster Response Force (NDRF)National Disaster Management Authority, States Disaster Management Authority, District Disaster Management Authority)-Emergency centres and their functions throughout the country-	2
2.3	Software on emergency controls, monitoring devices for detection of gases in the atmosphere. Early warning Systems Models in disaster preparedness.	2
2.4	Components of Disaster Relief (Water, food, sanitation, shelter, Health and Waste Management), Community based DRR, Policies for Disaster Preparedness Programs,	2
2.5	Preparedness Planning, Roles and Responsibilities, Public Awareness and Warnings, Rehabilitation measures and long-term reconstruction.	1
	Module 3	
3.1	Introduction to Sustainable Development-Bio Diversity-Atmospheric pollution-Global warming and Ozone Depletion-ODS banking and phasing out	2
3.2	Sea level rise-El Nino and climate changes-Eco friendly products	2
3.3	Green movements-Green philosophy-Environmental Policies-Environmental Impact Assessment	2
3.4	Life cycle Assessment	1
	Module 4	
4.1	Offshore and onshore drilling-control of fires-Case studies-	2
4.2	Marine pollution and control-Toxic, hazardous and Nuclear wastes-	2
4.3	state of India's and Global environmental issues-carcinogens-complex emergencies-	2
4.4	Earthquake disasters-the nature-extreme event analysis.	2

	Module 5	
5.1	Environmental education-Population and community ecology-Natural resources conservation-Environmental protection and law-Research methodology and systems analysis-Natural resources conservation,	2
5.2	Risk assessment process, assessment for different disaster types-Assessment data use, destructive capacity-risk adjustment-choice-loss acceptance disaster aid-	2
5.3	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,	3
5.4	Disaster Management Act-2005	1

Reference Books

1. Introduction to Environmental Engineering and Science, Gilbert, M. Masters
2. Environmental Science, Miller, G. Tylor
3. Environmental Science sustaining the earth, G. Tylor, Miller
4. Principles of Environmental Science and Engineering, Bagad Vilas.
5. Principles of Environmental Science and Engineering, R. Sivakumar R. Subramanian,
6. Disaster Management, Vikas Publishing House, 2018
7. M. M. Sulphey, Disaster Management, PHI Learning, 2016
8. UNDP, Disaster Risk Management Training Manual, 2016
9. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk Reduction 2015-2030, 2015

222ECH205	COMPUTER PROGRAMMING & SOFTWARE TOOLS IN HAZARD ANALYSIS	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

The objective of the course is to provide basic knowledge on risk, hazard and their assessment techniques in Industry, to understand and acquire the principles of operating various equipment for safety application and to acquire the knowledge on application of safety software in quantifying the risk assessment.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain different aspects of computer-based hazard analysis.
CO 2	Explain and evaluate risk using different softwares.
CO 3	Outline architectural design analysis.
CO 4	Explain design hazard and code analysis.
CO 5	Explain requirement hazards analysis.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3				
CO 2			3	3	3		
CO 3			3		2		
CO 4			3		2		
CO 5			3				

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%

Evaluate	
Create	

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 222ECH205

Max. Marks: 60 Duration: 150 minutes

COMPUTER PROGRAMMING & SOFTWARE TOOLS IN HAZARD ANALYSIS

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Explain different aspects of software design analysis.
2. Explain software requirement hazard analysis.
3. Explain hardware architechture.
4. Discuss software design hazards analysis.
5. Risk Estimation using Risk Matrix.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain in detail Waterfall Lifecycle model.
7. Discuss on software requirement hazard analysis.
8. Discuss outputs of Software Architecture Hazard Analysis.
9. Describe analysis procedures for code hazard analysis.
10. Discuss the application on PHAST.
11. Discuss the application of ALOHA.
12. Discuss on Preliminary Hazard List (PHL) and Preliminary Hazard Analysis(PHA).

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SYLLABUS
MODULE I (8 hours)
INTRODUCTION TO THE SOFTWARE HAZARD ANALYSIS PROCESS- Software Hazard Analysis as Part of System Safety Analysis-Software Hazard Analysis as Part of Software Design-Objectives-General Approach to Software Hazard Analysis-Prerequisites to Software Hazard Analysis-Preliminary Hazard List (PHL)-Preliminary Hazard Analysis(PHA)-Waterfall Life Cycle Model
MODULE II (8 hours)
REQUIREMENTS HAZARD ANALYSIS Software requirements specification on system hazards.-software requirements hazard analysis-Architectural Design-Detailed Design-Coding-Functionality & Reliability-Software Security-Sensor-Actuator-Operator Input & Output-Protection System Design Description- Analysis Procedures -Inputs to Software Requirements Hazard Analysis- Outputs of Software Requirements Hazard Analysis
MODULE III (8 hours)
ARCHITECTURAL DESIGN HAZARD ANALYSIS Hardware architecture, software architecture, Inputs to Software Architecture Hazard Analysis, Analysis Procedures, Outputs of Software Architecture Hazard Analysis
MODULE IV (8 hours)
DETAILED DESIGN HAZARD ANALYSIS Inputs to Software Detailed Design Hazard Analysis, Analysis Procedure, Outputs of Software Detailed Design Hazard Analysis **CODE HAZARD ANALYSIS** Inputs to Software Code Hazard Analysis, Analysis Procedures, Outputs of Software Code Hazard Analysis
MODULE V (8 hours)
RISK-ESTIMATION Scenarios from scenario-based Hazard Evaluations- Severity of consequence- Frequency of Initiating Causes- Effectiveness of Safeguards- Risk Estimation using Risk Matrix or Direct Calculation, Layer of Protection Analysis (LOPA), Safety Integrity Level (SIL). Hazard evaluation software aids – Risk Phast V 6.6 (DNV), ALOHA

Course Plan

No	Topic	No. of lectures
1	**Module 1 (8 hrs)**	
1.1	Software Hazard Analysis as Part of System Safety Analysis-Software Hazard Analysis as Part of Software Design	2
1.2	Objectives-General Approach to Software Hazard Analysis-Prerequisites to Software Hazard Analysis	2
1.3	Preliminary Hazard List (PHL)-Preliminary Hazard Analysis(PHA)	2
1.4	Waterfall Life Cycle Model	2
2	**Module 2 (8 hrs)**	
2.1	Software requirements specification on system hazards.-software requirements hazard analysis-Architectural Design	2
2.2	Detailed Design-Coding-Functionality & Reliability-Software Security-Sensor-Actuator-Operator Input & Output	2
2.3	-Protection System Design Description- Analysis Procedures -Inputs to Software Requirements Hazard Analysis	2
2.4	Outputs of Software Requirements Hazard Analysis	2
3	**Module 3 (8 hrs)**	
3.1	Hardware architecture, software architecture	2
3.2	Inputs to Software Architecture Hazard Analysis	2
3.3	Analysis Procedures	2
3.4	Outputs of Software Architecture Hazard Analysis	2
4	**Module 4 (8 hrs)**	
4.1	Inputs to Software Detailed Design Hazard Analysis	2
4.2	Analysis Procedure, Outputs of Software Detailed Design Hazard Analysis	2
4.3	Inputs to Software Code Hazard Analysis,	2
4.4	Analysis Procedures, Outputs of Software Code Hazard Analysis	2
5	**Module 5 (8 hrs)**	
5.1	Scenarios from scenario-based Hazard Evaluations- Severity of consequence	2
5.2	Frequency of Initiating Causes- Effectiveness of Safeguards- Risk Estimation using Risk Matrix or Direct Calculation	2
5.3	Layer of Protection Analysis (LOPA), Safety Integrity Level (SIL)	2
5.4	Hazard evaluation software aids – Risk Phast V 6.6 (DNV), ALOHA	2

Reference Books

1. Frank P. Lees Butterworth-Hein, “Loss Prevention in Process Industries” (Vol.I, II and III), \ Elsevier Butterworth-Heinemann, 3rd edition, 2005.
2. Raghavan K. V., Asad Ali Khan, “Methodologies for Risk and Safety Assessment in Chemical Process Industries”, Commonwealth Science Council, UK, 1990
3. Tarnaka and CLRI Course Material, “Intensive Training Programme on Consequence Analysis”, by Process Safety Centre, Indian Institute of Chemical Technology,Chennai.
5. ILO- Major Hazard control- A practical Manual, ILO, Geneva, 1993.5. Brown, D.B., “System Analysis and Design for safety,” Prentice Hall, 1976.
6. Trevor A Klett, “Hazop and Hazan,” Institute of Chemical Engineers, 2006
7. Centre for Chemical Process Safety, “Chemical Process Quantitative Risk analysis”, Institute of Chemical Engineers, 2000
8. “Guidelines for Hazard Evaluation Procedures”, Centre for Chemical Process safety, AICHE 3rd edition, 2008.
9. Layer of Protection Analysis, Centre for Chemical Process Safety, AICHE.

222ECH207	Safety In Material Handling	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: The objectives of this course is to imbibe knowledge on hazards involved in manual and mechanical material handling and selection, testing, usage, inspection and maintenance of material handling equipment

Course Outcomes: After the completion of the course the student will be able to

CO 1	Recognize the practical solutions to eliminate and/or minimize hazards in material handling.
CO 2	Describe legal requirements regarding material handling tools and tackles.
CO 3	Prepare lifting plan for crane operations.
CO 4	Understand different lifting tools and tackles.
CO 5	Prepare safe operation techniques of heavy equipments related to material handling.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3	3			
CO 2			3	3			
CO 3			3	3	3		
CO 4			3	3	3		
CO 5			3	3	3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 222ECH207

Max. Marks: 60 Duration: 150 minutes

Safety In Material Handling

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. List factors to be considered while inspecting wire rope slings.
2. What are the safety equipment required for conveyor?
3. Mention the legal requirements for a hoist.
4. List safety measures to be taken for a forklift.
5. Briefly explain regarding manual handling accessories for material handling.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Describe different lifting tools and tackles used for lifting. Also mention legal requirement regarding the same.
7. Explain ergonomic aspects regarding conveying equipment.
8. State legal requirement regarding hoisting equipment. Also describe safety aspects associated with hoists.
9. Prepare a lifting plan using sketch for tandem lifting of 150ton 8m long girder to be place on pier. Describe load angle, radius, safe lift, type of crane used.
10. Describe various safety systems available in a pick and carry crane.
11. In a scenario, oxygen cylinder and acetylene gas cylinder are kept together. Keeping in mind legal requirements for this, state the correct method. Also describe safety measures to be taken while storing compressed gas cylinders.
12. Describe storage plans/strategies for various items in an industry.

Course Plan

No	Topic	No. of lectures
	Module 1	
1.1	General safety consideration in material handling -lifting tools and tackles	1
1.2	Ropes, types, strength and working load inspection, rope in use, rope in storage	1
1.3	wire rope, construction, design factors, deterioration causes, sheaves and drums, lubrication, overloading, rope fitting, inspection and replacement	2
1.4	slings, types, method of attachment, rated capacities, sling angles while lifting, alloy chain slings, hooks and attachment	2
1.5	inspection -Manual material handling	2
1.6	preventing injuries- legal requirements	1
	Module 2	
2.1	Ergonomic consideration in material handling, design, installation, operation and maintenance of Conveying equipment	3
2.2	hoisting, traveling and slewing mechanisms.	3
	Module 3	
3.1	Ergonomic consideration in material handling, design, installation	3
3.2	operation and maintenance of driving gear for hoisting mechanism	2
3.3	Traveling mechanism-legal requirements	2
	Module 4	
4.1	Selection, operation and maintenance of Industrial Trucks, gasoline operated trucks, LPG trucks	1
4.2	Forklift	1
4.3	EOT cranes-Gantry cranes-Mobile Cranes – Tower crane –load angle	2
4.4	lifting plan	1
4.5	safety devices-inspection Checklist -Safe operating procedure	2
4.6	Man lifts, scissor lifts, Competent persons-legal requirements	2
	Module 5	
5.1	accessories for manual handling, hand tools, jacks, hand trucks, dollies and wheel barrows	2
5.2	Storage and Retrieval of common goods of various shapes and sizes in a general store of a big industry	2
5.3	storage of specific materials - problems with hazardous materials, liquids, solids,	2
5.4	storage of compressed gas cylinders	2
5.5	legal requirements	1

References

1. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.

2. Alexandrov, M.P., Material Handling Equipment, Mir Publishers, Moscow, 1981.

3. Rudenko N., Material Handling Equipments, Mir Publishers, Moscow, 1981.

4. Spivakosky, “Conveyors and Related Equipment”, Vol. I & II Peace Pub., Moscow, 1982.

5. Reymond, A. Kulwice, “Material Handling Hand Book - II”, John Wiley and Sons, New York, 1985.
6. “Safety and Good Housekeeping

222ECH209	Safety in Engineering industry	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

The main aim of this course to study various mechanical machines and their safety importance and to understand the principles of machine guarding and operation of protective devices.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Outline safety rules, standards and codes in mechanical engineering processes.
CO 2	Explain machine guarding systems for various machines such as lathe, drilling, boring, milling.
CO 3	Develop safe procedures for welding, gas cutting, storage and handling of gas cylinders
CO 4	Describe and suggest safety measures for cold forming and hot working of metals.
CO 5	Specify safety and welfare measures to be taken during finishing, inspection and testing of various mechanical processes.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3	1	2		
CO 2			3		2		
CO 3			3	2	1		
CO 4			3	2	3		
CO 5			3		1		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 222ECH209

Max. Marks: 60 Duration: 150 minutes

SAFETY IN ENGINEERING INDUSTRY

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Discuss safety requirements in wood working machinery
2. Define zero mechanical state and state its policies.
3. List common hazards involved in gas cutting activities.
4. Analyze the various health hazard associated with metal casting operations.
5. Describe safety measures to be taken for electroplating

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Prepare safety inspection checklist of turning machines
7. Illustrate different types of guarding systems.
8. Prepare safety checklist for arc welding activity
9. Analyse the various hazards in the forging industries and suggest suitable controls.
10. Explain in detail regarding pollution control measures in engineering industries.
11. Describe safety requirements for painting and sand blasting operations.
12. Explain safety requirements of gas furnace operations.

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Syllabus

MODULE I (8 hours)
SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES 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 - saws, types, hazards
MODULE II (7 hours)
PRINCIPLES OF MACHINE GUARDING Design aspects of machine guarding,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.
MODULE III (9 hours)
SAFETY IN WELDING AND GAS CUTTING 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.
MODULE IV (8 hours)
SAFETY IN COLD FORMING AND HOT WORKING OF METALS 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 sheers-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
MODULE V (8 hours)
SAFETY IN FINISHING, INSPECTION AND TESTING 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

Course Plan

No	Topic	No. of lectures
	Module 1	
1.1	General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines	3
1.2	Wood working machinery, types, safety principles	2
1.3	electrical guards, work area, material handling, inspection	2
1.4	standards- saws, types, hazards	1
	Module 2	
2.1	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	2
2.2	guard construction- guard opening. Selection and suitability: lathe-drilling-boring-milling grinding – shaping – sawing -shearing-presses-forge hammer-flywheels-shafts-	2
2.3	couplings-gears sprockets wheels and chains-pulleys and belts	1
2.4	authorized entry to hazardous installations-benefits of good guarding systems.	2
	Module 3	
3.1	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 sheers-press brakes	3
3.2	training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments.	2
3.3	safety in generation, distribution and handling of industrial gases-colour coding	2
3.4	flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.	2
	Module 4	
4.1	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 sheers-press brakes	2
4.2	Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures.	2
4.3	Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment	2
4.4	material handling in foundries, foundry production cleaning and finishing foundry processes	2
	Module 5	

5.1	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.	2
5.2	safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls	2
5.3	Indian Boilers Regulation. Health and welfare measures in engineering industry	2
5.4	pollution control in engineering industry- industrial waste disposal	2

Reference Books

1.“Accident Prevention Manual” – NSC, Chicago, 1982.

2.“Occupational safety Manual” BHEL, Trichy, 1988

3.“Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.

4.“Safety in Industry” N.V. Krishnan Jaico Publishery House, 1996

5.Indian Boiler acts and Regulations, Government of India.

6.Safety in the use of wood working machines, HMSO, UK 1992.

7.Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

222ECH211	COURSE NAME INDUSTRIAL NOISE & VIBRATION CONTROL	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: To learn about industrial noise and vibration, its control measures and legal requirements.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain industrial noise and its effect and methods for measurement of industrial noise.
CO 2	Characterize the single and multi-degree freedom systems subjected to free and forced vibrations with and without damping.
CO 3	Select the Acoustics of Rooms, Partitions, Enclosures, and Barriers for noise reduction.
CO 4	Apply the principles of vibration and noise reduction techniques to real-life engineering problems.
CO 5	Make use of the rules and regulations of Noise and vibration control.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3	3			
CO 2			3				
CO 3			3		3		
CO 4			3	3	3		
CO 5			3			3	
CO 6			3	3			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60 %
Analyse	40 %
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration

100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 222ECH211

Max. Marks: 60 Duration: 150 minutes

INDUSTRIAL NOISE & VIBRATION CONTROL

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Explain Loudness. How does it vary with frequency?
2. Classify the vibrators based on the degree of freedom systems
3. What are acoustic barriers? How will it reduce the sound level?
4. What are the various methods available for Noise control?
5. Explain the implementation of the Air act and Environmental protection act for noise and vibration control.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Briefly explain the wavelength and sound pressure level
7. Explain the Logarithmic decrement method and Half-power bandwidth method
8. Explain Transmissibility, b) Critical Speed, c) Dynamical Analogies
9. Write a note on Mufflers for High-Pressure Vents and Safety Valves
10. Explain the working of dynamic vibration absorbers. What are its main advantages?
11. How to estimate and Control Noise in cooling towers and turbines
12. State and Explain “The noise pollution (regulation and control) rules, 2000”

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SYLLABUS
MODULE I (8 hrs.)
Noise and its measurement Introduction of Noise- amplitude, frequency, wavelength, and sound pressure level, Logarithmic addition, subtraction and averaging, Decibel levels, Noise dose level, Loudness, Sources of industrial noise, effects, measurement, and analysis of noise, Frequency analysis, tracking analysis, sound quality analysis
MODULE II (8 hrs.)
Vibration and its measurement Classification of vibration: free and forced response vibration, undamped and damped vibration, linear and non-linear vibration, the response of damped and undamped systems under harmonic force, Analysis of single degree and two degrees of freedom systems, torsional vibration, Determination of natural frequencies, Transmissibility, Critical Speed, Dynamical Analogies, Vibration Measurement, Measurement of Damping, Logarithmic decrement method, Half-power bandwidth method
MODULE III (8 hrs.)
Acoustics of Rooms, Partitions, Enclosures, and Barriers Sound Field in a Room, Acoustics of a Partition Wall, Design of Acoustic Enclosures, Noise Reduction of a Partition Wall and Enclosure, Acoustics of Barriers, Mufflers and silencers- Electro-Acoustic Modelling, Transfer Matrix Modelling, Simple Expansion Chamber (SEC), Extended-Tube Expansion Chamber (ETEC), Extended Concentric Tube Resonator (ECTR), Mufflers for High-Pressure Vents and Safety Valves, Helmholtz Resonators, Active Noise Control in a Duct
MODULE IV(8 hrs.)
Noise and Vibration control Control of Noise, Estimation, and Control of Noise: Compressor, Fans and Blowers, Estimation and Control of Noise: Cooling Towers, Pump, Turbines, Diesel engines, Electric motors, Control of Vibration Control at the Source, Vibration Isolators, Dynamic Vibration Absorber (DVA), Damping Treatments for Plates, Active Vibration Control
MODULE V(8 hrs.)
Rules and Legislations Noise Limits in India- The noise pollution (regulation and control) rules, 2000, Permissible noise exposure for industrial workers -Noise limit for diesel generator sets -Noise limit for firecrackers-Noise limit for vehicles, The environment (Protection) Act, 1986, The control of vibration at work regulations 2005, Current standards and regulations: ISO and other relevant standards, Environmental Impact Assessment (EIA)

Corse Plan

No	Topic	No. of lectures
	Module 1	
1.1	Introduction of Noise- amplitude, frequency, wavelength, and sound pressure level	1
1.2	Logarithmic addition, subtraction and averaging, Decibel levels, Noise dose level, Loudness	2
1.3	Sources of industrial noise, effects, measurement, and analysis of noise	3
1.4	Frequency analysis, tracking analysis, sound quality analysis	2
	Module 2	
2.1	Classification of vibration: free and forced response vibration, undamped and damped vibration, linear and non-linear vibration, the response of damped and undamped systems under harmonic force	2
2.2	Analysis of single degree and two degrees of freedom systems, torsional vibration	2
2.3	Determination of natural frequencies, Transmissibility, Critical Speed, Dynamical Analogies	2
2.4	Vibration Measurement, Measurement of Damping, Logarithmic decrement method, Half-power bandwidth method	2
	Module 3	
3.1	Sound Field in a Room, Acoustics of a Partition Wall, Design of Acoustic Enclosures, Noise Reduction of a Partition Wall and Enclosure, Acoustics of Barriers	2
3.2	Mufflers and silencers- Electro-Acoustic Modelling, Transfer Matrix Modelling	2
3.3	Simple Expansion Chamber (SEC), Extended-Tube Expansion Chamber (ETEC)	1
3.4	Extended Concentric Tube Resonator (ECTR)	1
3.5	Mufflers for High-Pressure Vents and Safety Valves	1
3.6	Helmholtz Resonators, Active Noise Control in a Duct	1
	Module 4	
4.1	Control of Noise, Estimation, and Control of Noise: Compressor, Fans and Blowers	2
4.2	Estimation and Control of Noise: Cooling Towers, Pump, Turbines, Diesel engines, Electric motors	2
4.3	Control of Vibration Control at the Source	1
4.4	Vibration Isolators, Dynamic Vibration Absorber (DVA)	2
4.5	Damping Treatments for Plates, Active Vibration Control	1
	Module 5	
5.1	Noise Limits in India- The noise pollution (regulation and control) rules, 2000	2

5.2	Permissible noise exposure for industrial workers -Noise limit for diesel generator sets -Noise limit for firecrackers-Noise limit for vehicles	2
5.3	The environment (Protection) Act, 1986, The Air (prevention and control of pollution) Act, 1981, The control of vibration at work regulations 2005	2
5.4	Current standards and regulations: ISO and other relevant standards, Environmental Impact Assessment (EIA)	2

Reference Books

1. Istvan L. Ver and Leo L. Beranek, Noise and Vibration control engineering: Principles and applications, Second edition, John Wiley & Sons. Inc.
2. Noise and Vibration Control, Department of The Army and The Air force, 26 May 1995.
3. Singiresu S.Rao, "Mechanical Vibrations", 6th Edition, Pearson Education, 2016
4. David Bies colin Hansen, "Engineering Noise Control – Theory and Practice",4th E and FN Spon, Taylore & Francise e-Library, 2009
5. J.D. Irwin and E.R. Graf, Industrial Noise and Vibration Control: Prentice-Hall, Englewood Cliffs, N.J., 1979.
6. Munjal M.L, Noise and Vibration Control – IISC Lecture Notes Series: Volume 3, World Scientific, 2013

222ECH202	Safety in Hazardous material transport	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: The course covers the theory necessary for understanding the complete handling processes of a hazardous material from starting documentation, up to emergency response in case of an incident.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Illustrate the use of national and international standards and practices in hazardous material transport.
CO 2	Demonstrate various systems and their operation involved in hazardous material transportation
CO 3	Carry out hazard analysis of hazardous chemical transport
CO 4	Recommend the strategies for the prevention and control of hazards in hazardous material transport.
CO 5	Assess the safety features of various hazardous material transport systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3				
CO 2			3				
CO 3			3	3			
CO 4			3	3	3		
CO 5			3	3	3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyse	40
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry

7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 222ECH202

SAFETY IN HAZARDOUS MATERIAL TRANSPORT

Max. Marks: 60 Duration: 150 minutes

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Describe transport condition of a gas based on its physical state.
2. Outline the safety features of a rail tank car.
3. State the Rules for transport of Petroleum as per Petroleum Act and Rules.
4. Discuss various cargo tank designs utilised on board gas carriers.
5. Discuss the salient features of Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. A mixture containing three substances corrosive to the skin. Two of them A&B have specific concentration limits, for the third one C generic concentration limit applies. Rest of the mixture need not be taken into consideration. Assign packaging group for this mixture. Relevant information is given below.

Substance X in the mixture and its packing group assignment within Class 8	Concentration (conc) in the mixture in %	Specific concentration limit (SCL) for packing group I	Specific concentration limit (SCL) for packing group II	Specific concentration limit (SCL) for packing group III
A, assigned to packing group I	3	30 %	none	none
B, assigned to packing group I	2	20 %	10 %	none
C, assigned to packing group III	10	none	none	none

7. Prepare a security plan for the transportation of any high consequence dangerous goods.
8. Describe various design elements to ensure the safety of a tank truck carring flmmable

liquids.

9. Ethylene oxide is a flammable liquid having a normal boiling temperature below room temperature. Describe a system and a procedure for transferring ethylene oxide from a tank car through a pumping system to a storage tank.
10. Prepare a checklist for the inspection of city gas pipelines.
11. Discuss the safety practices for loading and unloading of a bulk carries.
12. Outline the reasons for outbreak of fire on board a ship. Discuss measures to mitigate the fire.

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SYLLABUS
MODULE I
Hazardous chemicals: Definition and characteristics, -NFPA diamond-MSDS- HAZCHEM code-TREM card. UN model Regulations on transportation of hazardous chemicals classification of hazardous chemicals- Dangerous goods list- Dangerous goods packed in limited quantities- Dangerous goods packed in excepted quantities-Packing and tank provisions-Consignment procedures-Requirements for construction and testing of packagings, intermediate bulk containers, large packaging, Portable tanks, Multiple element gas containers and bulk containers.
MODULE II
Transport of bulk petroleum products: Transportation by road-Design Criteria -Maximum Filling Volume -Details of Safety Appurtenances-Safety Related Features of Tank Trucks-Safety of Tank Trucks in Transit -Safety Recommendations at Unloading Point-Labelling of Containers, Training for tanker drivers Transportation by rail: Design Criteria-Filling considerations- Safety related features of the rail tank car.
MODULE III
Hydrocarbon pipelines- Ammonia Pipelines-Chlorine Pipelines-Natural gas transmission pipelines: Statutory Acts and Regulations related to natural gas transmission pipelines-Design-Pipeline system and components-Safety devices & features -materials-Corrosion Control-Construction-Testing and Commissioning-Operation and maintenance-Safety & fire protection system-Pipeline integrity management - Abandonment of pipeline -management of change-Defect assessment -Repair of pipeline. City Gas Distribution networks: Statutory regulations- Layout and facilities- Laying of pipeline-Testing and commissioning-Operation and maintenance-Emergency plan and procedures.
MODULE IV
Marine transport: Cargo ships: Dry cargo ships and bulk cargo ships- Typical vessel designs of Oil, chemical, LPG and LNG carrier-Regulatory controls for marine transport- Causes of ship board fire and fire protection systems-Transfer of hazardous materials between ship and shore: Systems for loading and unloading-Mooring system, loading arms, Pumping system and pressure relief. Hazards of ship to shore transfer and preventive measures.
MODULE V

Transport emergency planning and emergency control in pipeline road and marine transport. Transport case histories-Transport hazard analysis.

Course Plan

No	Topic	No. of Lectures
1	**MODULE I (8 hrs)**	
1.1	Hazardous chemicals: Definition and characteristics, -NFPA diamond-MSDS- HAZCHEM code-TREM card.	2
1.2	UN model Regulations on transportation of hazardous chemicals classification of hazardous chemicals- Dangerous goods list-Dangerous goods packed in limited quantities- Dangerous goods packed in excepted quantities-Packing and tank provisions-Consignment procedures	4
1.3	Requirements for construction and testing of packagings, intermediate bulk containers, large packaging, Portable tanks, Multiple element gas containers and bulk containers.	2
	MODULE II (8 hrs)	
2.1	Transport of bulk petroleum products: Transportation by road-Design Criteria -Maximum Filling Volume -Details of Safety Appurtenances-Safety Related Features of Tank Trucks-Safety of Tank Trucks in Transit -Safety Recommendations at Unloading Point-Labelling of Containers, Training for tanker drivers	4
2.2	Transportation by rail: Design Criteria-Filling considerations-Safety related features of the rail tank car.	4
	MODULE III (9 hrs)	
3.1	Hydrocarbon pipelines- Ammonia Pipelines-Chlorine Pipelines-Natural gas transmission pipelines: Statutory Acts and Regulations related to natural gas transmission pipelines	3
3.2	Design- Pipeline system and components-Safety devices & features -materials-Corrosion Control-Construction-Testing and Commissioning-Operation and maintenance-Safety & fire protection system-Pipeline integrity management - Abandonment of pipeline -management of change-Defect assessment -Repair of pipeline	4

3.3	City Gas Distribution networks: Statutory regulations- Layout and facilities- Laying of pipeline-Testing and commissioning-Operation and maintenance-Emergency plan and procedures.	2
	MODULE IV (8 hrs)	
4.1	Marine transport: Cargo ships: Dry cargo ships and bulk cargo ships- Typical vessel designs of Oil, chemical, LPG and LNG carrier-Regulatory controls for marine transport- Causes of ship board fire and fire protection systems-Transfer of hazardous materials between ship and shore	4
4.2	Systems for loading and unloading-Mooring system, loading arms, Pumping system and pressure relief. Hazards of ship to shore transfer and preventive measures.	4
	MODULE V (7 hrs)	
5.1	Transport emergency planning and emergency control in pipeline road and marine transport. Transport case histories-Transport hazard analysis.	7

Reference Books

1. Wendy Buckley, Hazardous Materials Transportation: A Guide to Success for Environmental, Health, & Safety Students and Professionals, Stars Hazmat Consulting 2021.
2. Recommendations of the UNCETDG contained in Orange Book.
3. Central Motor Vehicles Rules 1989.
4. Explosive Rules 2008.
5. Petroleum Rules 2002.
6. Manufacture, Storage and Import of Hazardous Chemical Rules 1989.
7. The Chemical Accidents (Emergency, Planning, Preparedness and Response) Rules 1986.
8. OISD 116, OISD 226.
9. Lees, F.P., “Loss Prevention in Process Industries” Butterworth publications, London, 3rd edition, 2005.
10. Emergency Response Guide book, US Department of Transportation 2020.

22ECH204	Nuclear Engineering and Safety	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: This course introduces the students to the fundamentals of nuclear power generation. Starting from the atomic structure students will get familiarise Operational principles and safety features of nuclear powerplants.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Recognize the regulatory practices for nuclear powerplants in India
CO 2	Illustrate the biological effects of radiation.
CO 3	Comprehend the complexity of the nuclear plant and explain the working of its different components.
CO 4	Assess safety features of nuclear powerplants.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1		3	3				
CO 2			3		2		
CO 3			3		2		
CO 4			3		2		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 222ECH204

Max. Marks: 60 Duration: 150 minutes

NUCLEAR ENGINEERING & SAFETY

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Uranium in nature consists of 99.3% U-238 with a half-life of 4.47 x 10^{9} years and 0.7% U235 with a half- life of 7.04 x 10^{8} years. Calculate the activity of one gram of natural uranium.

2. Discuss the factors which go in favour of nuclear power plant as compared to other types of power plants.

3. Draw an Event tree for a loss-of-coolant accident for the reactor. Assume missing data.

4. Outline medical application of nuclear radiation

5. Explain shutdown systems in PWR.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6.Isotope A decays to form Isotope B in a radioactive decay chain. Plot the relative quantities of A and B over a period of 100 hours for the following three cases:

(a) Half-life of A: 25 hrs. half-life of B: 4 hrs

(b) Half-life of A: 10 hrs. half-life of B: 10 hrs

(c) Half-life of A: 4 hrs, half-life of B :25 hrs

7. Outline various factors be considered while selecting the site for nuclear plant.

8. Explain why there is a variation in core size for a given output of the following reactors:

BWR

PWR

HTGR

FBR

Arrange these in order of core power density and state what puts one reactor ahead of another

9.Calculate the fuel utilization and infinite multiplication factor for a fast reactor consisting of a mixture of liquid sodium and plutonium, in which the plutonium is present to 3.0 w/o. The density of the mixture is approximately 1.0 g/cm3

10. Explain the purpose and principles of reactor shielding and containment.

11. Describe the characteristics of used nuclear fuel on discharge from a nuclear reactor and subsequently when in storage.

12. What is INES? How does INES apply to emergency exercises?

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SYLLABUS
MODULE I
Energy sources, Nuclear Power Production, medical and Societal applications of radiation Energy sources, Nuclear Power Production, medical and Societal applications of radiation. Atomic Structure, isotopes, Radioactivity, half-life Basics of fission reaction, Moderation, Criticality, Decay heat, Reactivity and Feedback, Breeding. Atomic Energy Regulatory Board, functions, safety Documents, Safety Review of site, design, regulatory inspections. Regulatory review of operating plants, Licensing stages, licensing of operating personnel, Training simulator, safety up-gradation Review after TMI Chernobyl.
MODULE II
Siting of Nuclear plants: Site evaluation Stages, Site Rejection Criteria, Earthquake, Geological criteria, Meteorological considerations Flooding, Tsunami, Shoreline erosion, chemical explosion, Radiological impact study, Radioactivity pathways to humans, environmental Impact study. Components of Nuclear Reactor, Present Reactor Types, Generation IV Concepts. Radiation and its units, Natural background and man-made Radiation, Biological Effects, Exposure limits and protection, Sources of radiation, shielding.
MODULE III
Safety objectives, Defence in depth philosophy, Multiple barriers, Rad-waste management Levels of defence, Redundancy, Diversity Principles, Event analysis, core inventory, emergency response. Deterministic approach- Design Basis Events & Beyond Design Basis Events, Acceptance Criteria Probabilistic approach- Fault tree, event tree, failure rates
MODULE IV
International Nuclear and Radiological Event (INES) Scale, History of events in nuclear reactor facilities: Three Mile Island (TMI), Chernobyl, Fukushima, Windscale, Thorp, Reprocessing, Kshtym, Vandellos, Tokaimura, NRX, David Besse, Enrico Fermi, Narora, Fire, Monju and FBTR Sodium Leak, Radiation over exposures in Industry and Medical applications.
MODULE V
Engineered Safety Systems: Shutdown systems in Pressurized water reactors (PWRs), boiling water reactors (BWRs), Pressurized heavy water reactors (PHWR), Reactivity Worth of shutdown system, Trip Signals, Safety Logic Operating Environment, Grouping of safety systems, Heat Removal systems, Emergency Core Cooling, Containment and subsystems.Basis of Containment, Quantity of Radioactive materials, Neutron activation of Structures, Transfer and deposition in buildings, Containment leak rate, Environmental Transport and Deposition, source term.

Course Plan

No	Topic	No. of Lectures
	MODULE I (8hrs)	
1.1	Energy sources, Nuclear Power Production, medical and Societal applications of radiation Energy sources, Nuclear Power Production, medical and Societal applications of radiation	2
1.2	Atomic Structure, isotopes, Radioactivity, half-life Basics of fission reaction, Moderation, Criticality, Decay heat, Reactivity and Feedback, Breeding	3
1.3	Atomic Energy Regulatory Board, functions, safety Documents, Safety Review of site, design, regulatory inspections. Regulatory review of operating plants, Licensing stages, licensing of operating personnel, Training simulator, safety up-gradation Review after TMI Chernobyl.	3
	MODULE II (8hrs)	
2.1	Siting of Nuclear plants: Site evaluation Stages, Site Rejection Criteria, Earthquake, Geological criteria, Meteorological considerations Flooding, Tsunami, Shoreline erosion, chemical explosion,	2
2.2	Radiological impact study, Radioactivity pathways to humans, environmental Impact study	2
2.3	Components of Nuclear Reactor, Present Reactor Types, Generation IV Concepts. Radiation and its units, Natural background and man-made Radiation, Biological Effects, Exposure limits and protection, Sources of radiation, shielding.	4
	MODULE III (8hrs)	
3.1	Safety objectives, Defence in depth philosophy, Multiple barriers, Rad-waste management Levels of defence, Redundancy, Diversity Principles, Event analysis, core inventory, emergency response	4
3.2	Deterministic approach- Design Basis Events & Beyond Design Basis Events, Acceptance Criteria Probabilistic approach- Fault tree, event tree, failure rates.	4

	MODULE IV (8hrs)	
4.1	International Nuclear and Radiological Event (INES) Scale	1
4.2	History of events in nuclear reactor facilities:Three Mile Island (TMI), Chernobyl, Fukushima, Windscale, Thorp, Reprocessing, Kshtym, Vandellos, Tokaimura, NRX, David Besse, Enrico Fermi, Narora, Fire, Monju and FBTR Sodium Leak	5
4.3	Radiation over exposures in Industry and Medical applications.	2
	MODULE V (8hrs)	
5.1	Engineered Safety Systems: Shutdown systems in Pressurized water reactors (PWRs), boiling water reactors (BWRs), Pressurized heavy water reactors (PHWR), Reactivity Worth of shutdown system, Trip Signals, Safety Logic Operating Environment, Grouping of safety systems, Heat Removal systems, Emergency Core Cooling, Containment and subsystems	4
5.2	Basis of Containment, Quantity of Radioactive materials, Neutron activation of Structures, Transfer and deposition in buildings, Containment leak rate, Environmental Transport and Deposition, source term	4

Reference Books

1. Vaidyanathan.G., Nuclear Reactor Engineering (Principles and Concepts), S.Chand & Company, New Delhi, 2013.
2. Jacques LIBMANN, Elements of Nuclear Safety, Les Editions de Physique 1996.
3. E.E. Lewis, Nuclear Power Reactor Safety, John Wiley and Sons, Inc., New York (1977). 630 pp
4. Gianni Petrangeli, Nuclear Safety, Butterworth Heinemann, 2006,488 pp.
5. NPTEL WEB COURSE on Nuclear Reactor Technology, K.S.Rajan, 2013

222ECH206	DESIGN & ANALYSIS OF EXPERIMENTS	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: Explore innovative strategies for constructing and executing experiments including factorial and fractional factorial designs. The identification of the objectives of the experiment and the practical considerations governing the design form the heart of the subject matter and serve as the link between the various analytical techniques. The learning about design and analysis of experiments is best achieved by the planning, running, and analysing of a simple experiment.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain various statistical methods of analysis of data.
CO 2	Investigate the logic of hypothesis testing, analysis of variance and the detailed analysis of experimental data.
CO 3	Describe the general theory of factorial design and blocking
CO 4	Discuss and apply regression analysis techniques to develop suitable models.
CO 5	Apply response surface methodology and explain its basic underpinnings.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2		3				
CO 2	3			3		2	
CO 3			3	3			
CO 4			3			3	
CO 5	2			3		3	

Assessment Pattern

Bloom's Category	End Semester Examination (%)
Apply	60
Analyse	40

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %. Total duration of the examination will be 150 minutes.

Model Question paper

QP CODE: **PAGES:**
Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 22ECH206

Max. Marks: 60 Duration: 150 minutes

DESIGN AND ANALYSIS OF EXPERIMENTS

PART – A

Answer All the Questions.
(5x 5 = 25)

1. What is meant by design of experiments?
2. Write a short note on estimation of the model parameters
3. Give two advantages of factorial designs
4. What is scaled residuals in regression model diagnostics
5. Briefly describe the method of steepest ascent in Response surface methodology

PART – B

Answer any five (5 x 7 = 35)

6. The viscosity of a liquid detergent is supposed to average 800 centistokes at 25^0C. A random sample of 16 batches of detergent is collected, and the average viscosity is 812. Suppose we know that the standard deviation of viscosity is $\sigma = 25$ centistokes
   (a) State the hypotheses that should be tested
   (b) Test these hypotheses using $\alpha = 0.05$. List your conclusions.
   (c) Find the P value for the test in part b.
   (d) Find a 95 % confidence interval on the mean.

7. The effective life of insulating fluids at an accelerated load of 35 kV is being studied. Test data have been obtained for four types of fluids. The results were as follows

Fluid type	Life in hr at 35 kV load					
1	17.6	18.9	16.3	17.4	20.1	21.6
2	16.9	15.3	18.6	17.1	19.5	20.3
3	21.4	23.6	19.4	18.5	20.5	22.3
4	19.3	21.1	16.9	17.5	18.3	19.8

   (a) Is there any indication that the fluids differ? Use $\alpha = 0.05$
   (b) Which fluid would you select given that the objective is long life
   (c) Analyse the residuals from this experiment. Is the basic analysis of variance assumptions satisfied?

8. Suppose that you are planning to run an experiment with three treatment factors, where the first factor has two levels and the other two factors have three levels each. Write out the coded form of the 18 treatment combinations. Assign 36 experimental units at random to the treatment combinations so that each treatment combination is assigned two units.

9.A bacteriologist is interested in the effects of two culturing media and two different times on the growth of a particular virus. She performs six replicates of 2^2 design making the runs in random order. Analyse the bacterial growth data that follow and draw the appropriate conclusions.

Time	Culture Medium			
	1		2	
12	21	22	25	26
	23	28	24	25
	20	26	29	27
18	37	39	31	34
	38	38	29	33
	35	36	30	35

10. The tensile strength of a paper product is related to the amount of hardwood in the pulp. Ten samples are produced in the pilot plant, and the data obtained are shown in the following table

Strength	% Hardwood	Strength	% hardwood
160	10	181	20
171	15	188	25
175	15	193	25
182	20	195	28
184	20	200	30

(a) Fit a liner regression model relating strength to percent hardwood
(b) Test the model in part (a) for significance of regression
(c) Find a 95 % confidence interval on the parameter β_1

11. An experimenter has run a Box-Behnken design and has obtained the results below, where the response variable is the viscosity of a polymer

Level	Temperature	Agitation rate	Pressure	X_1	X_2	X_3
High	200	10.0	25	+1	+1	+1
Middle	175	7.5	20	0	0	0
Low	150	5.0	15	-1	-1	-1

Run	X_1	X_2	X_3	Y1
1	-1	-1	0	535
2	+1	-1	0	580
3	-1	+1	0	596
4	+1	+1	0	563
5	-1	0	-1	645
6	+1	0	-1	458
7	-1	0	+1	350
8	+1	0	+1	600
9	0	-1	-1	595
10	0	+1	-1	648
11	0	-1	+1	532
12	0	+1	+1	656
13	0	0	0	653

14	0	0	0	599
15	0	0	0	620

(a) Fit the second order model

(b) Perform the canonical analysis. What type of surface has been found?

(c)

12. Explain the properties rotatability, orthogonal blocking, and orthogonality of central composite design (CCD).

SYLLABUS
MODULE I
INTRODUCTION TO DOE: Introduction to the role of experimental design, basic statistical concepts, sampling and sampling distribution, Hypothesis Testing, Inference about the difference in means and variances
MODULE II
ANALYSIS OF VARIANCE (ANOVA): Analysis of variance (ANOVA) -one-way classification of ANOVA, analysis of fixed effects model, estimation of model parameters, comparison among treatment means, random effects model; randomized designs and paired comparison designs, the randomized complete block design
MODULE III
FACTORIAL DESIGN: Factorial design of experiments; two-factor factorial design, analysis of fixed effects model, general factorial design, analysis of 2k and 3k factorial designs
MODULE IV
REGRESSION ANALYSIS: Simple and multiple linear regression, estimation of parameters in linear regression models, hypothesis testing in multiple regression, confidence intervals in multiple regression.
MODULE V
RESPONSE SURFACE METHODOLOGY: Introduction, method of steepness ascent, response surface designs for first-order models, response surface designs for second-order models.

Course Plan

No	Topic	No. of Lectures
	INTRODUCTION TO DoE	
1.1	Introduction to the role of experimental design	1
1.2	Basic statistical concepts, sampling, and sampling distribution	2
1.3	Hypothesis Testing	2
1.4	Inference about the difference in means and variances	2
	ANALYSIS OF VARIANCE	

2.1	Analysis of variance (ANOVA), One-way ANOVA	2
2.2	Analysis of fixed effects model, Estimation of model parameters	2
2.3	Comparison among treatment means	2
2.4	Random effects model; randomized designs and paired comparison designs	2
2.5	The randomized complete block design.	1
	FACTORIAL DESIGN	
3.1	Factorial design of experiments; two-factor factorial design	2
3.2	Analysis of fixed effects model	2
3.3	General factorial design	2
3.4	Analysis of 2k and 3k factorial designs	2
	REGRESSION ANALYSIS	
4.1	Regression analysis— Simple and multiple linear regression	2
4.2	Estimation of parameters in linear regression models	2
4.3	Hypothesis testing in multiple regression	2
4.4	Confidence intervals in multiple regression	2
	RESPONSE SURFACE METHODOLOGY	
5.1	Response surface methodology- Introduction	2
5.2	Method of steepness ascent	2
5.3	Response surface designs for first-order models.	2
5.4	Response surface designs for second-order models.	2

Reference Books

1. “Design and analysis of experiments” by D.C. Montgomery, 8th edition John Wiley and sons, New York.
2. “Applied Statistics and Probability for Engineers”, by D.C. Montgomery and G.C. Runger, 5th edition John Wiley and sons, New York.
3. “Design and analysis of experiments” by Klaus Hinkelmann, 2nd Edn. Wiley, New York.
4. “Introduction to Probability models” by Sheldon M. Ross, 10th Edn, Elsevier, USA.
5. “Response surface methodology” by R. H. Myers, D.C. Montgomery, C. M. Anderson-Cook, 2nd Edn, John Wiley and sons, New York.

222ECH208	DESIGN OF INDUSTRIAL VENTILATION SYSTEMS	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble:

This course will provide an understanding of systems, configuration and information needed to design industrial ventilation systems for real projects.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Compute exposure estimates for a dilution ventilation situation with variable input conditions
CO 2	Measure the flow characteristics of a ventilation system and apply this data for system diagnostics.
CO 3	Design and specify the components of a ventilation system.
CO 4	Develop models for ventilation systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3		3			
CO 2	2				3		
CO 3					3		
CO 4					3		
CO 5	2				3		
CO 6	3				3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyse	40
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration

100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10

Publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry

7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**

Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: 222ECH208

DESIGN OF INDUSTRIAL VENTILATION SYSTEMS

Max. Marks: 60 Duration: 150 minutes

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. sketch and explain typical components of HVAC ventilation systems.
2. Draw various arrangements of suction line
3. Discuss types of air distribution devices.
4. Explain fan characteristic curve.
5. Describe controlled ventilation system.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. A space is at a temperature of 24˚ C, and the relative humidity is 45 percent. Find

(a) the partial pressures of the air and water vapor.

(b) the vapor density

(c) the humidity ratio of the mixture. Assume standard sea-level pressure.

7. An air-handling system must handle 2000 cfm with a pressure drop of 0.25 in. wg available for the filter. The depth of the filter needs to be 8 inches or less. Select a filter system that will have a gravimetric efficiency of at least 95 percent in the particle size range of $0–5 \times 10^{-3}$ mm.

8. The M-200, 0.6 × 0.6 × 0.2 filters are to be used with a system having a volume flow rate of 0.40 m^3/s. What pressure drop across the clean filter and what filter face velocity would be expected?

9. The characteristic for a section of pipe may be represented by a function of the form

$H = aQ^2 + z$ where a is a constant, H is head, Q is flow rate, and z is elevation change. Derive an expression to represent the characteristic for pipe sections connected in

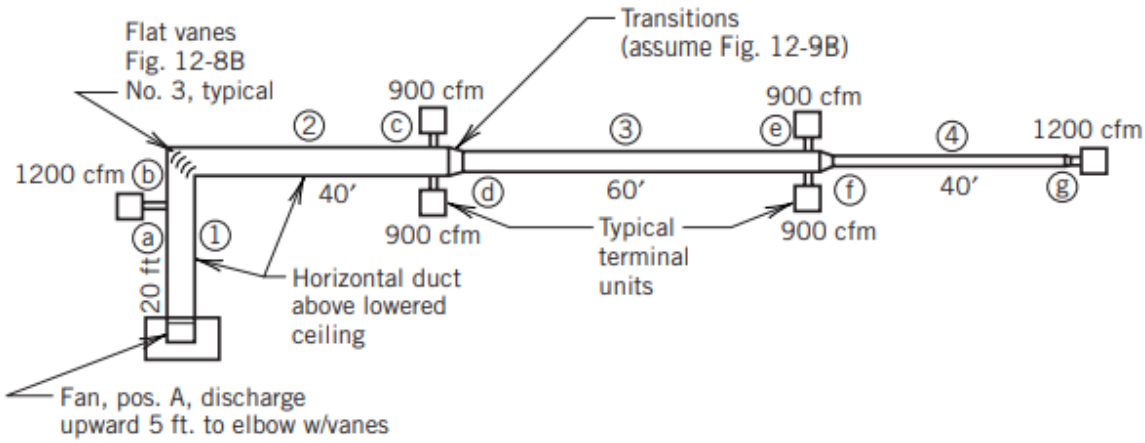
(a) series and (b) parallel.

10. A system requires a flow rate of 225 gpm (14.2 L/s) at a head of 140 ft (43 m) of water. Select a pump for this system.

(a) Sketch the pump and system characteristics, and show the operating flow rate, efficiency, and power, assuming no adjustments.

(b) Assume that the system has been adjusted to 225 gpm (14.2 L/s) and find the efficiency and power.

11. Design the duct system shown in using the static regain method. A minimum of 0.5 in. wg static pressure is required at each takeoff. Other pertinent data are shown on the sketch. The ducts are located in a lowered ceiling space above a hall where space is limited.



12. A small system requires 0.88 in. wg (0.22 kPa) total pressure at a flow rate of 1420 cfm (0.67 m^3/s). Select a suitable fan for this purpose. (a) Sketch the system and fan characteristics, showing the operating point. (b) What are the fan speed and power?

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Syllabus

SYLLABUS
MODULE I
Introduction- Fundamentals of good indoor air quality, Need for building ventilation, Effects of R.H. in building ventilation, Control of microbial growth, Psychometric performance of contact volume system. Types of ventilation system. Supply system, Exhaust system.
MODULE II
Devices Used in Supply Systems: Air Inlet system. Filters heating & cooling equipment, Fans, Duct, Grills, Diffusers, for distribution of air in the work place.
MODULE III
Exhaust Systems: General exhaust systems. Local exhaust system, Removal of pollutants and contaminated air. Air cleaning devices, Fans.
MODULE IV
Ventilation of Commercial Building: Design of commercial, Residential ventilation system.
MODULE V
Modelling of ventilation system, Thermal building model, air flow model, visual

Course Plan

No	Topic	No. of Lectures
1.1	Introduction- Fundamentals of good indoor air quality, Need for building ventilation, Effects of R.H. in building ventilation, Control of microbial growth	4
1.2	Introduction- Fundamentals of good indoor air quality, Need for building ventilation, Effects of R.H. in building ventilation, Control of microbial growth	4
2.1	Devices Used in Supply Systems: Air Inlet system. Filters heating & cooling equipment, Fans	4
2.2	Duct, Grills, Diffusers, for distribution of air in the work place.	4
3.1	Exhaust Systems: General exhaust systems. Local exhaust system,	4
3.2	Removal of pollutants and contaminated air. Air cleaning devices, Fans.	4
4.1	Ventilation of Commercial Building: Design of commercial, Residential ventilation system.	8
5.1	Modelling of ventilation system, Thermal building model, air flow model, visual	8

Reference Books

1. Wark, K., Warner, C.F., and Davis, W.T., “Air Pollution: Its Origin and Control”, Addison-Wesley Longman. 1998.
2. Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., “Fundamentals of Air Pollution”, Academic Press. 2005.
3. Seinfeld, J.H., Pandis, S.N., “Atmospheric Chemistry and Physics”, John Wiley. 2006.
4. Lodge, J.P. (Ed.), “Methods of Air Sampling and Analysis”, CRC Press. 1988.
5. Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), “Air Pollution: Health and Environmental Impacts”, CRC Press. 2010.
6. Kenneth C. Schifftner - Air Pollution Control Equipment Selection Guide-CRC Press (2021).
7. Goodfellow H D, Tahti E, “Industrial Ventilation Design Handbook”. Academic Press, 2001.
8. Alden J L, Kane J M, “Design of Industrial Ventilation Systems”. 5th Edition, Industrial Press, 1982.

222ECH210	SAFETY IN HIGH PRESSURE SYSTEMS AND VACUUM TECHNOLOGY	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: This course will help students to develop knowledge of requirements for safe design, operation, and maintenance of high pressure and vacuum systems.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain basic engineering principles related to high pressure processes
CO 2	Interpret the design standards of high pressure system
CO 3	Describe measuring devices and testing equipment of high pressure systems
CO 4	Explain valve sizing and vacuum instrumentation
CO 5	Identify and comply with statutory and regulatory requirement

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3		3		
CO 2			3		3		
CO 3			3		3		
CO 4			3		3		
CO 5			3		3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyse	40
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry

7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Total duration of the examination will be 150 minutes.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 222ECH210

Max. Marks: 60 Duration: 150 minutes

SAFETY IN HIGH PRESSURE SYSTEMS AND VACUUM TECHNOLOGY

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1.Explain phase equilibrium of high-pressure systems.
2.Describe materials used for high pressure system components.
3.Explain the testing methods of gas cylinders and unfired pressure vessel.
4.Write notes on gas flow regimes in high pressure system.
5.Describe various applications of vacuum technology.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. With the help of flow diagram explain working of coal fire power plants keeping focus on high pressure components.
7. Explain in detail about high pressure centrifugal pump and turbo compressors pumps.
8.Describe standard valve sizing procedure.
9. Explain in detail regarding different types of vacuum pumps.
10. Summarise the main features of Boilers Act, 1923
11. Summarise the main features of Gas Cylinder Rule,2016
12. Describe rotating and reciprocating positive displacement machines used in high pressure systems.

****

Syllabus

SYLLABUS
MODULE I
Specifics of High-Pressure Processes- Thermodynamic Aspects: Phase Equilibrium - Phase Equilibrium: Experimental Methods and Measuring Devices - Interfacial Phenomena and Data - Material Properties and Transport Data for Heat and Mass Transfer - Evaporation and Condensation at High Pressures - Thermodynamics as Driver for Selection of High Pressure - Ammonia Synthesis Process – Urea Process - General Aspects of HP Equipment - Coal-Fired Steam Power Plants - Steam Generator - High-Pressure Steam Turbines.
MODULE II
High-pressure components: Materials for High-Pressure Components - Pressure Vessels - Heat Exchangers – Valves – Piping. High-pressure pumps and compressors: Selection of Machinery - Influence of the Fluid on Selection and Design of the Machinery - Design Standards for High-Pressure Machines - Materials and Materials Testing - High-Pressure Centrifugal Pumps and High-Pressure Turbo compressors- Rotating Positive Displacement Machines - Reciprocating Positive Displacement Machines.
MODULE III
High-pressure measuring devices and test equipment: Process Data Measuring – Online Lab Determination -Additional Offline Test Equipment - Safety Aspects – Future. Type testing and Periodic testing of gas cylinders, unfired pressure vessels, cryogenic pressure vessels And Boilers. Sizing of high-pressure safety valves for gas service: Standard Valve Sizing Procedure - Limits of the Standard Valve Sizing Procedure - Development of a Sizing Method for Real Gas Applications - Sizing of Safety Valves for Real Gas Flow.
MODULE IV
Basic Theory: Gas kinetic theory, pressure, conductance, gas flow regimes, vapour pressure, pumping speed, throughput. Gas surface interactions: physisorption, chemi-sorption,

condensation. Vacuum Pumps: Mechanical, diffusion, molecular drag, turbo molecular, cryopumps, ion pumps - general working principles, operating regimes. Vacuum Instrumentation: Vacuum gauges, gas regulators, flow meters, residual gas analyzers, interpretation of data.
MODULE V
Design Concepts: Materials, chambers, components, joins, seals, valves. Overall system design and integration. Problem Solving: Leak detection and detectors, gas signatures. Vacuum Applications: Freeze drying, packaging, vacuum coating, microelectronics, particle accelerators, distillation, metallurgical processes, television and X-ray tubes, cryogenic insulation, space simulation. Standards and legal requirements: Static and Mobile Pressure Vessels (Unfired) Rules 2016, Gas cylinder Rules 2016, Boiler Act 1923, Design codes: IS 2825; ASME Section VIII Division 1 or Division 2, PD5500, EN 13458, EN 13530, AD:2000 code, Software tools for Design of pressure vessels.

Course Plan

No	Topic	No. of Lectures
	Module 1 (8hrs)	
1.1	Specifics of High-Pressure Processes- Thermodynamic Aspects: Phase Equilibrium - Phase Equilibrium: Experimental Methods and Measuring Devices - Interfacial Phenomena and Data - Material Properties and Transport Data for Heat and Mass Transfer	4
1.2	Evaporation and Condensation at High Pressures - Thermodynamics as Driver for Selection of High Pressure - Ammonia Synthesis Process – Urea Process - General Aspects of HP Equipment - Coal-Fired Steam Power Plants - Steam Generator - High-Pressure Steam Turbines.	4
	Module 2 (8hrs)	
2.1	High-pressure components: Materials for High-Pressure Components - Pressure Vessels - Heat Exchangers – Valves – Piping.	3

2.2	High-pressure pumps and compressors: Selection of Machinery - Influence of the Fluid on Selection and Design of the Machinery - Design Standards for High-Pressure Machines - Materials and Materials Testing - High-Pressure Centrifugal Pumps and High-Pressure Turbo compressors- Rotating Positive Displacement Machines - Reciprocating Positive Displacement Machines.	5
3.1	High-pressure measuring devices and test equipment: Process Data Measuring – Online Lab Determination -Additional Offline Test Equipment - Safety Aspects – Future. Type testing and Periodic testing of gas cylinders, unfired pressure vessels, cryogenic pressure vessels And Boilers.	4
3.2	Sizing of high-pressure safety valves for gas service: Standard Valve Sizing Procedure - Limits of the Standard Valve Sizing Procedure - Development of a Sizing Method for Real Gas Applications - Sizing of Safety Valves for Real Gas Flow.	4
	Module 4 (7hrs)	
4.1	Basic Theory: Gas kinetic theory, pressure, conductance, gas flow regimes, vapour pressure, pumping speed, throughput. Gas surface interactions: physisorption, chemi-sorption, condensation.	3
4.2	Vacuum Pumps: Mechanical, diffusion, molecular drag, turbo molecular, cryopumps, ion pumps - general working principles, operating regimes. Vacuum Instrumentation: Vacuum gauges, gas regulators, flow meters, residual gas analyzers, interpretation of data.	4
	Module 5 (9 hrs)	
5.1	Design Concepts: Materials, chambers, components, joins, seals, valves. Overall system design and integration. Problem Solving: Leak detection and detectors, gas signatures. Vacuum Applications: Freeze drying, packaging, vacuum coating, microelectronics, particle accelerators, distillation, metallurgical processes, television and X-ray tubes, cryogenic insulation, space simulation.	4
5.2	Standards and legal requirements: Static and Mobile Pressure Vessels (Unfired) Rules 2016, Gas cylinder Rules 2016, Boiler Act 1923, Design codes: IS 2825; ASME Section VIII Division 1 or Division 2, PD5500, EN 13458, EN 13530, AD:2000 code, Software tools for Design of pressure vessels.	5

Reference Books

1. Rudolf Eggers (Editor). Industrial High-Pressure Applications: Processes, Equipment, and Safety, Wiley, 2012.
2. V.V. Rao, T.B. Ghosh, K.L. Chopra, Vacuum Science and Technology, Allied Publishers Ltd., New Delhi
3. A. Roth, Vacuum Technology, North Holland Publishing Company, Amsterdam.
4. Static and Mobile Pressure Vessels (Unfired) Rules 2016.
5. Gas cylinder Rules 2016.
6. Boiler Act 1923
7. Design codes: IS 2825; ASME Section VIII Division 1 or Division 2, PD5500, EN 13458, EN 13530, AD:2000 code.

222ECH212	SAFETY IN MINES AND POWER PLANTS	CATEGORY	L	T	P	CREDIT
		PEC	3	0	0	3

Preamble: The objective of this course is to provide insight into the operational principles of powerplants and mines, identify various hazards associated with them and propose measures to mitigate those hazards.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Recognize the scale and scope of hydroelectric power plants, steam power plants, diesel power plants, gas turbine power plants and nuclear power plants
CO 2	Describe the complexity of power plants and their components and elements.
CO 3	Summarize the safety issues related to power plants and the current scenario of national and international debates on the same
CO 4	Outline various hazards in mines and propose strategies to mitigate those hazards
CO 5	Effectively employ their knowledge in accident prevention in mines and power plants

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3	3			
CO 2			3		3		
CO 3			3		3		
CO 4			3		3		
CO 5			3		3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60
Analyse	40
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students).Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %. Total duration of the examination will be 150 minutes

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 222ECH212

Max. Marks: 60 Duration: 150 minutes

SAFETY IN MINES & POWER PLANTS

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Explain the significance of load curve

2. A diesel engine has a brake thermal efficiency of 30%. If the calorific value of fuel used in 10000 kcal kg, calculate the brake specific fuel consumption.

3.Explain principal parts of nuclear reactor in brief.

4. Outline various methods to prevent fire and explosion accidents in mine

5.Summarize guidelines s to be followed while working with heavy machinery.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Draw a general layout of thermal power plant and explain working of various circuits in it.

7. The maximum (peak) load on a thermal power plant of 60 mW capacity is 50 mW at an annual load factor of 50%. The loads having maximum demands of 25 mW, 20 mW, 8 mW and, 5 mW are connected to the power station. Determine: (a) Average load on power station (b) Energy generated per year (c) Demand factor (d) Diversity factor

8. Distinguish between water-tube and fire-tube boilers and state under what circumstances each type would be desirable.

9. Outline principal hazards in mining industry.

10. Explain working of any four types of gas detectors with neat sketch

11. A gas turbine plant of 800 kW capacities takes the air at 1.01 bar and 15°C. The pressure ratio of the cycle is 6 and maximum temperature is limited to 700°C. A regenerator of 75% effectiveness is added in the plant to increase the overall efficiency of the plant. The pressure drop in the combustion chamber is 0.15 bars as well as in the regenerator is also 0.15 bars.

Assuming the isentropic efficiency of the compressor 80% and of the turbine 85%, determine the plant thermal efficiency. Neglect the mass of the fuel

12. What is a steam trap? Where it is located? Describe Ball Float steam trap.

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SYLLABUS
MODULE I
Power plant economics – base load and peak load power plants -estimation of load – load curve – load factor – diversity factor – capacity factor – use factor – selection of units – number and size – scheduling operation – cost of energy – depreciation and replacement – economics of plant selection. Hydroelectric power plants – general layout – types of dams – penstock, draft tubes, surge tanks - power house equipment – site selection
MODULE II
Diesel engine power plant – Layout – Components of a diesel power plant – starting methods – Gas turbine – open and closed cycles – thermodynamics cycles – regeneration – reheating – intercooling – efficiency and performance of gas turbines. Combustion chambers of gas turbines – cylindrical – annular and industrial type combustion chamber design– combustion efficiency – advantages and disadvantages. Gas Turbine power plants – classification – elements of a Gas Turbine power plant
MODULE III
Steam power plants - General layout – fuel handling systems – types of furnaces – stokers – burning systems – types of firing: stokers, pulverized coal burners and fluidized bed combustion - power plant boilers, mountings and accessories - dust and ash handling systems – draft and chimney calculations – condensers – cooling systems - Environmental aspects of thermal power systems. Nuclear power plants - Fundamentals of nuclear fission – reactors – classification – components layout of simple plant – nuclear power safety and waste disposal.
MODULE IV
Causes and prevention of accident from: Heavy machinery, belt and bucket conveyors, drilling, hand tools-pneumatic systems, pumping, water, dust, electrical systems, fire prevention. Garage safety – accident reporting system-working condition-safe transportation – handling of explosives.
MODULE V
Fall of roof and sides-effect of gases-fire and explosions-water flooding-warning sensors-gas detectors-occupational hazards-working conditions-winding and transportation.

Course Plan

No	Topic	No. of Lectures
	MODULE I	
1.1	Power plant economics – base load and peak load power plants - estimation of load – load curve – load factor – diversity factor – capacity factor – use factor	4
1.2	selection of units – number and size – scheduling operation – cost of energy – depreciation and replacement – economics of plant selection	3
1.3	Hydroelectric power plants – general layout – types of dams – penstock, draft tubes, surge tanks - power house equipment – site selection	1
	MODULE II	
2.1	Diesel engine power plant – Layout – Components of a diesel power plant – starting methods	1
2.2	Gas turbine – open and closed cycles – thermodynamics cycles – regeneration – reheating – intercooling – efficiency and performance of gas turbines.	4
2.3	Combustion chambers of gas turbines – cylindrical – annular and industrial type combustion chamber design– combustion efficiency – advantages and disadvantages.	2
2.4	Gas Turbine power plants – classification – elements of a Gas Turbine power plant	1
	MODULE III	
3.1	Steam power plants - General layout – fuel handling systems – types of furnaces – stokers – burning systems – types of firing: stokers, pulverized coal burners and fluidized bed combustion	3
3.2	power plant boilers, mountings and accessories - dust and ash handling systems – draft and chimney calculations – condensers – cooling systems - Environmental aspects of thermal power systems.	3
3.3	Nuclear power plants - Fundamentals of nuclear fission – reactors – classification – components layout of simple plant – nuclear power safety and waste disposal	2
	MODULE IV	
4.1	Causes and prevention of accident from: Heavy machinery, belt and bucket conveyors, drilling, hand tools-pneumatic systems, pumping, water, dust, electrical systems, fire prevention	4
4.2	Garage safety – accident reporting system-working condition-safe transportation – handling of explosives.	4
	MODULE V	
5.1	Fall of roof and sides-effect of gases-fire and explosions-water flooding	2
5.2	warning sensors-gas detectors-	2
5.3	occupational hazards-working conditions-winding and transportation.	4

Reference Books

1. Wakil, E. I., Power Plant Technology, McGraw Hill, (1985).
2. Nag, P. K., Power Plant Engineering, 3rd Edition, Tata McGraw Hill, (2007).
3. Morse, Power Plant Engineering, Van Nostrand Co., (1953).
4. Lee J. F., Power Station Engineering and Economy, Tata McGraw Hill, (1960).
5. Robert L. Loftness, Nuclear Power Plants, Van Nostrand, (1964).
6. Verma Mahesh, Power Plant Engineering, Metropolitan Book Co., (1976).
7. Rai G. D., Non Conventional Energy Sources, Khanna Publishers, (2004). 8.Cohen & Rogers, Gas Turbine Theory, 6th Edition, Prentice Hall, (2008).
8. DGMS Circulars-Ministry of Labour, Government of India press, OR Lovely Prakashan - DHANBAD, 2002.
9. Kejiriwal, B.K. Safety in Mines, Gyan Prakashan, Dhanbad, 2001.
10. “Mine Health and Safety Management”, Michael Karmis ed., SME, Littleton, Co.2001.

222ECH24	PROCESS SAFETY ENGINEERING	CATEGORY	L	T	P	CREDIT
		IDE	3	0	0	3

Preamble: The subject aims to impart students with knowledge and skill for Identifying and controlling the hazards for chemical process plant during design and operation.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Differentiate inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants
CO 2	Explain the safety aspects of chemical plant operation
CO 3	Apply suitable techniques to identify and quantify the hazards in an industry.
CO 4	Estimate the consequences of fire, explosion and toxic gas release using suitable empirical models and calculate the risk.
CO 5	Devise strategies to prevent or limit the potential damage from fires and explosions

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3		3	3			
CO 2	3		3	3			
CO 3	3		3	3			
CO 4	3		3	3			
CO 5	3		3	3			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60 %
Analyse	40 %
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications (minimum 10

Publications shall be referred)	: 15 marks
Course based task/Seminar/Data collection and interpretation	: 15 marks
Test paper, 1 no.	: 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry7 marks.

Model Question paper

QP CODE: **PAGES:**
Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
222ECH214
PROCESS SAFETY ENGINEERING

Max. Marks: 60 Duration: 150 minutes

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Illustrate the importance of colour coding of pipelines in chemical process plants.
2. Explain standard operating procedure for pumps.
3. How do we calculate the RPN? Discuss the significance of RPN in process safety.
4. Recommend a suitable procedure for the calculation of over pressure due to an explosion.
5. What is static electricity? How it is generated? Give industrial examples where generation of static electricity occurs. Briefly describe the safety precautions to avoid fire and explosions due to static electricity.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. List phases of procedure during start up of a chemical process plant. What are the general hazards during start up?
7. A 1000 m^3 storage vessel contains liquid methyl alcohol (CH4O). The vessel is padded with a gas mix obtained from a membrane separation unit. The gas from the membrane unit contains 98% nitrogen (plus 2% oxygen). The vessel is padded to a total pressure of 10 mm Hg gauge. We must prepare the vessel for entry for the annual inspection of the inside of the vessel. The liquid is first drained from the tank prior to this operation, and then the empty tank must be inerted using a sweep purging method prior to opening the vessel and allowing air to enter. Assume an ambient temperature of 25°C and 1 atm.

a. What is the concentration of gas (in vol. %) within the tank after draining the liquid and prior to inerting?

b. Use a triangle diagram to estimate the target fuel concentration (in vol. %) for the inerting operation.

c. If we use a sweep purging inerting procedure, using the 98% nitrogen sweep gas from the membrane unit, how much total sweep gas (in m3 at 25°C and 1 atm) is required to achieve the desired target concentration? d. If the gas from the membrane unit is supplied at the rate of 5 kg/min, how long (in min) will it take to achieve the desired target concentration?

8. A liquid storage tank is filled by pump P1. It has a level indicator LI, a level alarm LA and a trip LT at successively higher levels. The pump discharge line to the storage tank has independent shut off valves V1 and V2, both of which are operator actuated. LI is simply an indicator; LA has an audible alarm and LT automatically trips the pump in case of a very high level. Draw a fault tree for the top event Tank overflows. Estimate the probability of overflow using the following data.

Event	Description	Probability
A	Valve V1 stuck open	0.01
B	Valve V2 stuck open	0.01
C	Level indicator LI fails flow	0.01
D	Level alarm LA fails	0.0005
E	Pump trip fails	0.005
H	Operator fails to respond to LI	0.03
K	Operator fails to respond to LA	0.01

9. Determine the evaporation rate from a 10m dia pool of pentane at an ambient temperature of 296 K. The pool is on wet sand and the solar energy input rate is 642 J/m^2 s.

Wind speed	4.9m/s
Molecular weight	72
Heat of vaporisation	27 kJ/mol
V.P at ambient temperature	0.652 bar abs.
Kinematic Viscosity of air	$1.5x10^{-5}$ m^2/s
Diffusivity of air	$7.1x10^{-6}$ m^2/s

10. Determine the concentration in PPM, 500m downwind from a 0.1 Kg/s ground release of a gas. The gas has a molecular weight of 30. Assume a temperature of 298 K, a pressure of 1 atmosphere, F stability with a 2m/s wind speed. The release occurs in rural area. Assume σy=19.52m, σz=6.96m.
11. What do you mean by inherent safer design? Outline various techniques of inherent safer design with suitable examples.
12. Explain various types of valves and sizing of valves.

SYLLABUS
Module 1 (8 hours)
Safety in the design of chemical process plants :-Design principles – Process design development –types of designs, feasibility survey, preliminary design, flow diagrams, piping and instrumentation diagram, batch versus continuous operation, - reliability and safety in designing – inherent safety – engineered safety - safety during start up and shutdown – safety checks in the design of the equipments – reactor safety - safety in erection and commissioning of chemical plants -Colour coding of pipelines– emergency safety devices – scrubbers and flares –Inspection techniques for boilers and reaction vessels.
Module 2 (8 hours)
Safety in the operation of chemical process plants: - Properties of chemicals – Material Safety Data Sheets – the various properties and formats used – methods available for property determination. Operational activities and hazards –standards operating procedures – safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems – effects of pressure, temperature, flow rate and humidity on operations – corrosion and control measures- condition monitoring - control valves – safety valves – pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.
Module 3 (6 hours)
Techniques for Hazard Identification: Hazard and Operability Study, Preliminary Hazard Analysis, What if Analysis. Fault tree Analysis, Event Tree Analysis- methodology and application in industrial scenario, Failure Modes and Effects Analysis, Criticality and risk priority number, Bow –tie analysis, Examples.
Module 4 (10 hours)
Consequence Analysis and Quantitative Risk Assessment: CPQRA steps- source models- Dispersion models: Plume and puff models Consequences modelling: Models for pool fire and jet fire, Models for explosion- TNT model, Modelling of BLEVE. ALARP, Acceptance criteria for risk, Presentation of measures of risk – risk contour, F-N curve. Calculation of individual risk and Societal risk. Selection of Risk Measures and Presentation format, Risk.
Module 5 (8 hours)
Techniques for preventing fire and explosion in process plants: Inerting - Use of the flammability diagram -Static electricity - Controlling static electricity -Ventilation -Explosion-proof equipment and instruments -Sprinkler systems -Miscellaneous design features for preventing fires and explosions

Course Plan

No	Topic	No. of Lectures
1	**Safety in the design of chemical process plants (8 hrs)**	
1.1	Design principles – Process design development –types of designs, feasibility survey, preliminary design, flow diagrams, piping and instrumentation diagram, batch versus continuous operation, - reliability and safety in designing – inherent safety – engineered safety	4

1.2	safety during start up and shutdown – safety checks in the design of the equipments – reactor safety - safety in erection and commissioning of chemical plants	2
1.3	emergency safety devices – scrubbers and flares –Inspection techniques for boilers and reaction vessels	2
2	**Safety in the operation of chemical process plants (8 hrs)**	
2.1	Properties of chemicals – Material Safety Data Sheets – the various properties and formats used – methods available for property determination.	2
2.2	Operational activities and hazards –standards operating procedures – safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems – effects of pressure, temperature, flow rate and humidity on operations – corrosion and control measures	4
2.3	condition monitoring - control valves – safety valves – pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.	2
3	**Techniques for Hazard Identification: (6hrs)**	
3.1	Hazard and Operability Study, Preliminary Hazard Analysis, What if Analysis.	2
3.2	Fault tree Analysis, Event Tree Analysis- methodology and application in industrial scenario	2
3.3	Failure Modes and Effects Analysis, Criticality and risk priority number, Bow –tie analysis, Examples.	2
4	**Consequence Analysis and Quantitative Risk Assessment (10 hours)**	
4.1	CPQRA steps- source models	2
4.2	Dispersion models: Plume and puff models	2
4.3	Models for explosion- TNT model, Modelling of BLEVE	2
4.4	ALARP, Acceptance criteria for risk, Presentation of measures of risk – risk contour, F-N curve. Calculation of individual risk and Societal risk. Selection of Risk Measures and Presentation format, Risk.	4
5	**Techniques for preventing fire and explosion in process plants**	
5.1	Inerting - Use of the flammability diagram	3
5.2	Static electricity - Controlling static electricity	2
5.3	Ventilation -Explosion-proof equipment and instruments	1
5.4	Sprinkler systems -Miscellaneous design features for preventing fires and explosions.	2

Reference Books

1. Crowl, D. and Louvar, J.F., “Chemical Process Safety: Fundamentals with applications”, Prentice Hall, 2011
2. Guidelines for Hazard Evaluation Procedures Centre for Chemical Process Safety, AIChE, 1992.

3. Sam Mannan, Lees' Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control, 4th edition, 2012.
4. K S N Raju, Chemical Process Industrial Safety, McGraw Hill Education.
5. Ralph King and Ron Hirst. King’s safety in the process industries. Arnold, London. (1998).

222ECH216	Waste To Energy Conversion	CATEGORY	L	T	P	CREDIT
		IEC	3	0	0	3

Preamble: This course discusses the production of energy from different types of wastes using technologies through different routes, via thermal, biological and chemical. This course aims to update the knowledge of students in the area of waste utilization for energy production through newer technologies

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Analyse the characteristics of wastes used to produce energy.
CO 2	Describe the use of incineration technology and analyse its environmental impact.
CO 3	Explain the basic chemistry, schemes and use of gasification as a method of waste to energy conversion and compare the same with other technologies .
CO 4	Outline the mechanism, types and use of pyrolysis as a waste to energy conversion technology.
CO 5	Select suitable biochemical/chemical routes for conversion of waste to energy.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3		3		
CO 2			3		3		
CO 3			3		3		
CO 4			3		3		
CO 5			3	3	3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%

Evaluate	
Create	

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry7 marks.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
222ECH038: WASTE TO ENERGY

Max. Marks: 60 Duration: 150 minutes

PART A

Answer All the Questions.

One question from each module, having 5 marks for each question **(5x5= 25 marks)**

1. Discuss the classification of solid wastes.
2. Discuss the environmental impact of incineration and their solution.
3. Compare gasification with incineration.
4. Discuss different types of pyrolysis and their product distribution.
5. Discuss the mechanism and pathways for anaerobic digestion.

PART B

Minimum one question from each module (Total seven questions)

Answer any five **(5x7= 35 marks)**

6. What are the parameters to be checked to find out the suitability of waste for energy conversion? Explain.
7. The composition of flue gas (dry basis) from an incinerator is as follows: 12.3% CO_2 , 5.1% O_2 , and the rest is nitrogen. From these data, calculate a) The weight ratio of hydrogen to carbon in the waste b) The percent carbon and hydrogen in the dry waste c) The percent excess air used d) The moles of exhaust gas discharged from the unit per kilogram dry waste burnt.
8. A dry MSW has the following composition on mass basis: C: 40 %, H: 5 %, O: 30 % and Ash:25 %. Determine the stoichiometric oxygen requirement for the combustion of the MSW. Assume the ash as inert and average molecular weight of ash is 56. If the ratio of nitrogen to oxygen in air is 4:1 (v/v), determine the stoichiometric requirement of air.
9. A fast pyrolysis plant handles 1TPD MSW and produces gas, char and liquor. Operating temperature and pressure of the reactor are 788^{o}C and 1 atm., respectively. The gas composition (vol %) is H_2 - 37.16, CO- 35.50), CH_4 - 11.10, CO_2- 16.3). The mass % of production of gas, char and oil are 30, 25 and 45 respectively. Determine the product distribution with individual components of gas and the rate of hydrogen production assuming 90 % separation efficiency for hydrogen.

10. Discuss the conversion of plastic to fuel through pyrolysis.
11. In a high-rate biogas plant food waste is anaerobically digested to produce biogas. The slurry contains 8 % of solid food grains. The elemental composition of the food grains on dry basis is C: 58%, H:8%, O:26%, N:8% (mass basis). Around 80 % of the food grains are converted to biogas and all the converted hydrogen forms methane. If the flowrate of the slurry is 4500 litre per day, calculate the rate of biogas (CO_2 + CH_4) production.
12. Explain the process of wastewater treatment using algae.

SYLLABUS
MODULE I (7 hours)
Introduction: Definition of wastes and their classification, Important quality parameters of different types of wastes, Waste suitable for energy production, Solid wastes and their classification, Wastewater and their classification. Need of energy production from wastes, present status of WTE technologies. Characterization of solid wastes: Physical, Chemical, Proximate and ultimate analysis, Fusing point of ash, Lignocellulosic composition, Leaching properties, Energy content: Heating value, Characterization of wastewater. Combustion: Nature and types of combustion processes – Mechanism
MODULE II (8 hours)
Incineration: Definition and scope for application, Mechanism, Air requirement, Performance factors and staged combustion, Advantages and disadvantages, Preferable feedstocks characteristics for incineration, Process flowsheet, Incinerators parts and their types/working, Environmental impact and operational issues
MODULE III (8hours)
Gasification: Definition and Basic chemistry of gasification, Gasification reaction schemes and steps, Syngas production and efficiency and Factors influencing gasification, Advantages of gasification, Typical process flowsheet and Utilization schemes for gasification products, Syngas conditioning and clean up, Gasifier types, Gasifiers for biomass and wastes, Comparison between incineration and gasification
MODULE IV (8 hours)
Pyrolysis: Definition of pyrolysis, mechanism, Types of pyrolysis, Operating conditions and end product distribution, Use of pyrolysis products, Properties of bio-oil and need of its upgradation, Catalytic pyrolysis, Pyrolysis reactors, Utilization of pyro char and gases Options for management of plastic wastes and recycling through pyrolysis, Pyrolysis process types and their variables, Common steps for converting waste plastics to fuels
MODULE V (9 hours)
Energy production through biochemical and chemical routes: Anaerobic digestion for biogas production: Mechanism of anaerobic digestion, Microorganisms for anaerobic digestion, Pathways for anaerobic digestion, Pre-treatment of lignocellulosic biomass and wastes, Type of

anaerobic digestion process, Kinetics of methane formation, Anaerobic digester and their types, Operation of anaerobic digester, Impurities in biogas and their impacts

Fermentation: Production of ethanol from different feedstocks and pre-processing steps, microorganisms and product recovery, Ethanol production through gasification route

Transesterification: Organic wastes for transesterification, Production of bio-oil from oil seeds and its major composition

Wastewater treatment using Algae

Course Plan

No	Topic	No. of lectures
	Module 1	
1.1	Definition of wastes and their classification	1
1.2	Important quality parameters of different types of wastes, Waste suitable for energy production	1
1.3	Solid wastes and their classification	1
1.4	Wastewater and their classification	1
1.5	Need of energy production from wastes, present status of WTE technologies	1
1.6	Characterization of solid wastes – Physical – Chemical, Proximate and ultimate analysis, fusing point of ash, Lignocellulosic composition, Leaching properties, Energy content: Heating value	1
1.7	Characterization of wastewater	1
	Module 2	
2.1	Definition and scope for application	1
2.2	Mechanism, Air requirement,	1
2.3	Performance factors and staged combustion	1
2.4	Advantages and disadvantages, Preferable feedstocks characteristics for incineration	1
2.5	Process flowsheet	1
2.6	Incinerators parts and their types/working	2
2.7	Environmental impact and operational issues	1
	Module 3	
3.1	Definition and Basic chemistry of gasification	1
3.2	Gasification reaction schemes and steps	1
3.3	Syngas production and efficiency and Factors influencing gasification	1
3.4	Advantages of gasification	1
3.5	Typical process flowsheet and Utilization schemes for gasification products	1
3.6	Syngas conditioning and clean up	1

3.7	Gasifier types, Gasifiers for biomass and wastes	1
3.8	Comparison between incineration and gasification	1
	Module 4	
4.1	Definition of pyrolysis, mechanism,	1
4.2	Types of pyrolysis	1
4.3	Operating conditions and end product distribution	1
4.4	Use of pyrolysis products, Properties of bio-oil and need of its upgradation	1
4.5	Catalytic pyrolysis, Pyrolysis reactors, Utilization of pyro char and gases	1
4.6	Options for management of plastic wastes and recycling through pyrolysis	1
4.7	Pyrolysis process types and their variables,	1
	Module 5	
5.1	Anaerobic digestion for biogas production: Mechanism of anaerobic digestion, Microorganisms for anaerobic digestion, Pathways for anaerobic digestion	1
5.2	Pre-treatment of lignocellulosic biomass and wastes, Type of anaerobic digestion process,	1
5.3	Kinetics of methane formation, Anaerobic digester and their types	1
5.4	Operation of anaerobic digester, Impurities in biogas and their impacts	1
5.5	Fermentation: Production of ethanol from different feed stocks and pre-processing steps	1
5.6	microorganisms and product recovery, Ethanol production through gasification route	1
5.7	Transesterification: Organic wastes for transesterification	1
5.8	Production of bio-oil from oil seeds and its major composition	1
5.9	Wastewater treatment using Algae	1

Reference Books

1. Rogoff, M.J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation", Elsevier Store.
2. Young G.C., "Municipal Solid Waste to Energy Conversion processes", John Wiley and Sons.
3. Harker, J.H. and Backhusrt, J.R., "Fuel and Energy", Academic Press Inc.
4. EL-Halwagi, M.M., "Biogas Technology- Transfer and Diffusion", Elsevier Applied Science.
5. Hall, D.O. and Overeed, R.P.," Biomass - Renewable Energy", John Willy and Sons.
6. Mondal, P. and Dalai, A.K. eds., 2017. Sustainable Utilization of Natural Resources. CRC Press.

222ECH218	HYDROGEN ENERGY PRODUCTION, STORAGE, TRANSPORTATION & SAFETY	CATEGORY	L	T	P	CREDIT
		IEC	3	0	0	3

Preamble: To gain knowledge regarding various Hydrogen production technics and its transport and its safety aspects

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain different methods of hydrogen reforming.
CO 2	Explain different methods of hydrogen production.
CO 3	Describe different techniques of hydrogen storage and the challenges involved.
CO 4	Describe long distance hydrogen transportation and its use in IC engines
CO 5	Formulate safety measures for hydrogen storage and transport

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3				
CO 2			3				
CO 3			3				
CO 4			3				
CO 5			3	2			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer-reviewed original publications (minimum 10 publications shall be referred) : 15 marks
Course-based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 No : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Model Question Paper

QP CODE: **PAGES:**
Reg No: **Name:**

SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: 222ECH218

Max. Marks: 60 Duration: 150 minutes

HYDROGEN ENERGY PRODUCTION, STORAGE, TRANSPORTATION & SAFETY

PART – A

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. State briefly about the methods of hydrogen production.
2. Explain the production of hydrogen using electrolysis.
3. Explain regarding hydrogen liquefaction and its storage.
4. Discuss transportation of hydrogen through road.
5. Discuss on the properties of hydrogen that makes it hazardous to transport.

PART – B

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain (1) steam methane reforming (ii) autothermal reforming.
7. Explain the production of hydrogen through (i) pyrolysis (ii) coal gasification
8. Describe briefly about various hydrogen compressors.
9. Explain usage of hydrogen in internal combustion engines and its challenges.
10. Discuss regulatory provisions regarding hydrogen storage and transport
11. Discuss on the future of hydrogen use in internal combustion engines and its viability.
12. Discuss on the solid state hydrogen storage techniques.

SYLLABUS
MODULE I (8 hours)
Properties of Hydrogen. Status of Hydrogen Supply and Demand-Methods of Hydrogen Production-categories of hydrogen production-steam reforming-carbon deposition and catalyst deactivation-water gas shift-purification-Steam methane reforming-Partial Oxidation Method for Hydrogen Production-Autothermal Reforming-Combined, Dry, Bi and Tri Reforming - Reforming using Alternate Energy Sources-solar, nuclear, thermal or non-thermal plasma reforming
MODULE II (7 hours)
Hydrogen Production by Methane Decomposition-Hydrogen Production from Biomass-pyrolysis, gasification, combustion-Hydrogen Production from Coal-coal gasification-Hydrogen purification methods-Thermochemical Cycles for Hydrogen Production-Electrolysis of Water for Hydrogen Production- Electrolytic Cell Components and Electrolyzer stack-Photoelectrochemical Hydrogen Production
MODULE III (10 hours)
Introduction to Hydrogen Storage-Underground Hydrogen Storage-Fundamentals of Hydrogen Compression and Expansion-Thermodynamics of Hydrogen Compression-Reciprocating and Diaphragm compressors for Hydrogen Compression-Linear and Liquid Hydrogen Compressors-Cryogenic and Metal Hydride based Hydrogen Compressors-Electrochemical and Adsorption based Compressors-Compressed Hydrogen Tanks-Hydrogen Liquefaction- Liquid State Hydrogen Storage- Fundamentals of Adsorption based Materials for Hydrogen Storage-Adsorption based Solid State Hydrogen Storage Material- Metal Hydrides for Solid-State Hydrogen Storage-Novel Materials and Overall Storage
MODULE IV (7 hours)
Hydrogen Transportation via H2 Pipelines- Long Distance Hydrogen Transmission, transportation via road-Hydrogen Refuelling Stations-Use of Hydrogen in Internal Combustion Engines-Hydrogen Sensors-Use of Hydrogen in Fuel Cells
MODULE V (8 hours)
Properties of Hydrogen Associated with Accidents- Classification of Hydrogen related Hazards-Compressed and Liquid Hydrogen Related Hazards-Regulations, Codes and Standards-Utilisation in Different Sectors, Global Status and Future Directions

Course Plan

No	Topic	No. of lectures
	Module 1	
1.1	Properties of Hydrogen. Status of Hydrogen Supply and Demand-Methods of Hydrogen Production-categories of hydrogen production-	2
1.2	steam reforming-carbon deposition and catalyst deactivation-water gas shift-purification-Steam methane reforming-	2
1.3	Partial Oxidation Method for Hydrogen Production-Autothermal Reforming-Combined, Dry, Bi and Tri Reforming -	2
1.4	Reforming using Alternate Energy Sources-solar, nuclear, thermal or non-thermal plasma reforming	2
	Module 2	
2.1	Hydrogen Production by Methane Decomposition-Hydrogen Production from Biomass-pyrolysis, gasification, combustion	2
2.2	Hydrogen Production from Coal-coal -coal gasification-Hydrogen purification methods	2
2.3	Thermochemical Cycles for Hydrogen Production-Electrolysis of Water for Hydrogen Production-	1
2.4	Electrolytic Cell Components and Electrolyser stack-Photoelectrochemical Hydrogen Production	2
	Module 3	
3.1	Introduction to Hydrogen Storage-Underground Hydrogen Storage-Fundamentals of Hydrogen Compression and Expansion-Thermodynamics of Hydrogen Compression	2
3.2	Reciprocating and Diaphragm compressors for Hydrogen Compression-Linear and Liquid Hydrogen Compressors-	2
3.3	Cryogenic and Metal Hydride based Hydrogen Compressors-Electrochemical and Adsorption based Compressors-Compressed Hydrogen Tanks-Hydrogen Liquefaction- Liquid State Hydrogen Storage-	3
3.4	Fundamentals of Adsorption based Materials for Hydrogen Storage-Adsorption based Solid State Hydrogen Storage Material- Metal Hydrides for Solid-State Hydrogen Storage-Novel Materials and Overall Storage	3
	Module 4	
4.1	Hydrogen Transportation via H2 Pipelines	1
4.2	Long Distance Hydrogen Transmission, transportation via road	2
4.3	Hydrogen Refuelling Stations--Use of Hydrogen in Internal Combustion Engines-	2
4.4	Hydrogen Sensors-Use of Hydrogen in Fuel Cells	2
	Module 5	
5.1	Properties of Hydrogen Associated with Accidents- Classification of Hydrogen related Hazards	2
5.2	Compressed and Liquid Hydrogen Related Hazards	2
5.3	Regulations, Codes and Standards	2
5.4	Utilisation in Different Sectors, Global Status and Future Directions	2

Reference Books

1. Gupta, R. B., Hydrogen Fuel: Production, Transport and Storage, CRC Press, Taylor & Francis Group, 2009.
2. Global Hydrogen Review 2021, IEA (2021), Paris, https://www.iea.org/reports/global-hydrogen-review-2021
3. AgataGodula-Jopek, Hydrogen Production by Electrolysis, Wiley-VCH, Germany, 2015
4. Tzimas, E., Filiou, C., Peteves, S.D., &Veyret, J.B. “Hydrogen storage: state-of-the-art and future perspective. Netherlands”: European Communities, 2003.
5. Michael Hirscher, “Handbook of Hydrogen Storage”, Wiley-VCH, 2010.

222PCH100	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PROJECT	0	0	4	2

Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem-solving skills. The introduction of mini projects ensures the preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with PG Programme Coordinator that should lead to their dissertation/research project. Demonstrate the novelty of the project through the results and outputs.

The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Evaluation Committee – Programme Coordinator, One Senior Professor and Guide.

Sl.No	Type of Evaluations	Mark	Evaluation criteria
1	Interim evaluation 1	20	
2	Interim evaluation 2	20	
3	Final evaluation by a Committee	35	Will be evaluating the level of completion and demonstration of functionality/ specifications, clarity of presentation, oral examination, work knowledge and involvement
4	Report	15	The committee will be evaluating for the technical content, adequacy of references, templates followed and permitted plagiarism level(not more than 25%)
5	Supervisor/Guide	10	
	Total Marks	100	

222LCH002	INDUSTRIAL SAFETY LABORATORY – II	CATEGORY	L	T	P	CREDIT
		PCC	0	0	2	2

Preamble: The course is aimed at giving practical experience in demonstration of safety gadgets including personal protective equipment and to study sensitivity and reactivity characteristics of hazardous chemicals

Course Outcome:

At the end of the course, the students will be able to

CO 1	Choose appropriate fire extinguisher based on class of fire
CO 2	Check the performance of fire extinguisher and suitability of extinguishing agent
CO 3	Distinguish and choose right personal protective equipment for various practices
CO 4	Analyse the outcomes of the models or simulations to make meaningful conclusions for systems involving Health, Safety and Environment

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3

Assessment:

Continuous Internal Evaluation: 100 marks

List of experiments:

1. Friction Sensitivity Test

   Measurement of friction sensitivity for unstable materials: *Instrument – BAM friction tester*
2. Impact Sensitivity Test

   Measurement of impact sensitivity for unstable materials: *Instrument – BAM fall hammer*
3. Thermal Reactivity Test

   Measurement of thermal reactivity for unstable materials: *Instrument – DSC/TGA*
4. Study of Personal Protective Equipment:

   Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, apron and leg guard.
5. Consequence Analysis

   Soft computing skills on developing effects of fire & explosion and dispersion: *Software – RISK PHAST V 6.6 (DNV) and ALOHA.*
6. Tank Testing Experiment

   Measurement of Pressure-Time and Temperature-Time relationship of gas generant compositions on ignition used in Automotive Airbag applications.
7. Static Electricity Measurement of Fuels

   Conductivity measurement of low conductivity hydrocarbon fuels using conductivity meter.
8. Development of empirical models for advanced oxidation Processes Factorial design.
9. Modelling of oxygen sag curve.
10. Kinetic modelling of advanced oxidation process, biological wastewater treatment process.
11. Dispersion modelling of gaseous pollutants.
12. Modelling the effect of fire and explosion using PHAST-1/FLACS software.
13. Study of softwares AERMOD, CHARM, SCREEN 3
14. Measurement of ergonomic impact using OWAS software