MRT 401	ADVANCED AUTOMATION SYSTEMS	CATEGORY	L	T	P	CREDIT
		PCC	2	1	0	3

Preamble:

This course is aimed to

- Make students familiar with automation and control technologies in modern manufacturing
- Provide knowledge on the elements of modern manufacturing systems
- Examine the mechanisms of CMM and FMS
- Determine the modern application of automation systems in manufacturing industry

Prerequisite:

NIL

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

CO 1	Understand the principles of automation systems and to determine the relationship between product and production
CO 2	Analyse the different elements of automation system and to find the importance of control systems in automation
CO 3	Classify the manufacturing systems and what are the components of manufacturing systems
CO 4	Define Group technology and understand about CMM
CO 5	Explain about Machine vision in manufacturing system and FMS

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1		1								
CO 2	3	2	1	2								2
CO 3	3	3										
CO 4	3	3	2	2								2
CO 5	3	2										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	25	25	25
Understand	15	15	45
Apply	10	10	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain different types of production system facilities.
2. What do you mean by the USA principle?
3. Describe product/production relationship with an example.
4. Manual labor is unavoidable in manufacturing. Justify.
5. What are the limitations and capabilities of a manufacturing plant?

Course Outcome 2 (CO2):

1. Describe advanced automation function in the manufacturing system.
2. What are the elements of automated systems?
3. Explain about different types of control systems in a manufacturing system.
4. Define levels of automation. Explain in detail.

Course Outcome 3 (CO3):

1. What are the components of a manufacturing system?
2. Explain about the learning curve.
3. How can we classify manufacturing systems?

Course Outcome 4 (CO4):

1. Define group technology. Explain how it's done?
2. Explain about contact and non-contact inspection techniques.
3. With a neat sketch, explain about CMM construction. Explain its application.

Course Outcome 5 (CO5):

1. With a neat sketch, explain in detail about machine vision. Explain its importance in the manufacturing system.
2. What is meant by FMS? Explain its components and application.
3. Differentiate between lean and agile manufacturing.

MODEL QUESTION PAPER

MRT 401

ADVANCED AUTOMATION SYSTEMS

Max. Marks : 100 **Duration : 3 Hours**

Part – A

(Answer all questions, each question carries 3 marks)

1. Explain the ten strategies of automation systems.
2. What are the limitations and capabilities of a manufacturing plant?
3. Explain how safety monitoring is done in manufacturing systems.
4. Differentiate between continuous and discrete control systems.
5. Describe the objectives of material handling systems.
6. Classify FMS workstations and give its features.
7. List down the advantages of cellular manufacturing.
8. Differentiate between contact and non-contact inspection techniques with the help of examples.
9. What are the applications of machine vision?
10. Explain the material handling system.

PART -B

Answer one full question from each module.

MODULE – 1

11. a. Write a short note on manual labor in the production system. (4 marks)

b. Explain in detail about the ten strategies of automation systems. (10 marks)

OR

12. a. Explain about automation migration strategy. (5 marks).

b. Discuss the factors that are determining how the products are being manufactured. (9 marks)

MODULE – 2

13. **a**. Write a short note on error detection and recovery in an automated system. (8 marks).

b. Differentiate between different modes of control systems with the help of diagrams. (6 marks).

OR

14. a**.** Explain in detail about the elements of an automated system. (10 marks).

b**.** Explain why advanced automation functions are implemented in manufacturing systems. (4 marks)

MODULE – 3

15. What are the components of manufacturing systems? Explain the role of human resources in manufacturing systems. (14 marks)

OR

16. a. Briefly explain classification of manufacturing systems. (8 marks).

b. Define learning curves. Explain its importance in manufacturing systems. (6 marks)

MODULE – 4

17. a. Explain group technology. List the application of group technology. (10 marks).

b. List any four CMM softwares. (4 marks)

OR

18. a. Define CMM. (4 marks).

b. Describe about six types of mechanical structure of CMM. (10 marks)

MODULE – 5

19. a. Describe about image acquisition and digitalization, image processing and analysis and interpretation (10 marks)

b. Explain the importance of machine vision in manufacturing? (4 marks).

OR

20. a. Define FMS (4 marks).

b. Describe about the types of flexible manufacturing systems and mentioned its features (10 marks)

SYLLABUS

Module 1

Production system facilities-Manufacturing support systems - Automation in production systems-manual labor in production systems - automation principles and strategies - USA principle-ten strategies of Automation and Production Systems - Automation Migration strategy-manufacturing industries and products-manufacturing operations-processing and assembly operations-product / production relationships- production quantity and product variety-limitations and capabilities of a manufacturing plant.

Module 2

Elements of an automated system - power to accomplish the automated process - program of Instructions-control systems -advanced automation functions - safety monitoring-maintenance and repair diagnostics - Error detection and recovery - levels of automation, variables and parameters in process industries and discrete manufacturing industries - continuous and discrete control systems - computer process control - control requirements - capabilities of computer control and levels of industrial process control-computer process monitoring-direct digital control-numerical control and robotics-PLC

Module 3

Components of a manufacturing system - production machines - material handling system - computer control system-human resources - classification of manufacturing systems - types of operations performed-number of workstations - automation levels - part or product variety - Type I type II and type III manufacturing systems-manufacturing progress functions - learning curves.

Module 4

Part families - parts classification and coding-features and examples of part classification and coding systems - production flow analysis - cellular manufacturing - application of group technology. Inspection metrology - contact and non-contact inspection techniques - conventional measuring and gauging techniques - coordinate measuring machines - CMM construction - CMM operation and planning - CMM software - CMM applications and benefits.

Module 5

Machine vision - image acquisition and digitizing - image processing, digitizing analysis and interpretation - machine vision applications. Flexible manufacturing systems - types of FMS - FMS components - workstations - material handling and storage systems - computer control systems - human resources - FMS applications and benefits - FMS planning and implementation issues - FMS planning and design issues - FMS operational issues. Comparison of lean and agile manufacturing.

Text Books

1. Mikell P Groover, Automation, Production Systems and Computer –Integrated Manufacturing, Pearson Education

Reference Books

1. Radhakrishnan, P Subramanian S,CAD/CAM and CIM ,Wiley Eastern
3. HMT Mechatronics, TATA Mc Graw Hill

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1		
1.1	Production system facilities-Manufacturing support systems-Automation in production systems	1
1.2	Manual labor in production systems-automaton principles and strategies-USA principle-ten strategies of Automation and Production Systems.	1
1.3	Automation Migration strategy-manufacturing industries and products	1
1.4	manufacturing operations-processing and assembly operations	1
1.5	product /production relationships-production quantity and product variety	2
1.6	Limitations and capabilities of manufacturing plant	1
2		
2.1	Elements of an automated system- power to accomplish the Automated process-program of Instructions-control systems	1
2.2	advanced automation functions-safety monitoring-maintenance and repair diagnostics-Error detection and Recovery	2
2.3	levels of automation, variables and parameters in process industries and discrete manufacturing industries	1
2.4	continuous and discrete control systems-computer process control-control requirements	1
2.5	capabilities of computer control and levels of industrial process control-computer process monitoring-direct digital control	1
2.6	direct digital control-numerical control and robotics-PLC	1
3		
3.1	Components of a manufacturing system-production machines-material handling system-computer control system-human resources	2
3.2	classification of manufacturing systems-types of operations performed-number of work stations	2
3.3	automation levels-part or product variety-Type I type II and type III manufacturing systems	2
3.4	manufacturing progress functions-learning curves	1

4		
4.1	Part families-parts classification and coding-features and examples of part classification and coding systems	2
4.2	production flow analysis – cellular manufacturing - application of group technology	1
4.3	Inspection metrology-contact and non-contact inspection techniques-conventional measuring and gauging techniques	2
4.4	Coordinate measuring machines-CMM construction-CMM operation and planning-CMM software-CMM applications and benefits.	2
5		
5.1	Machine vision-image acquisition and digitizing-image processing, digitizing analysis and interpretation- machine vision applications	2
5.2	Flexible manufacturing systems-types of FMS-FMS components-workstations	1
5.3	material handling and storage systems-computer control systems-human resources-FMS applications and benefits	1
5.4	FMS planning and implementation issues-FMS planning and design issues- FMS operational issues	2
5.5	Comparison of lean and agile manufacturing.	1

MCN401	INDUSTRIAL SAFETY ENGINERING	Category	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: The course is intended to give knowledge of various safety management principles, various safety systems, various machine guarding devices, hazard identification techniques, energy sources, systems & applications and the need in the present context. Learners will be able to compare different hazard identification tools and choose the most appropriate based on the nature of industry. It aims to equip students in working with projects and to take up research work in connected areas

Prerequisite: Nil

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

CO1	Describe the theories of accident causation and preventive measures of industrial accidents. (Cognitive Knowledge level: **Understand**)
CO2	Explain about personal protective equipment, its selection, safety performance & indicators and importance of housekeeping. (Cognitive Knowledge level: **Understand**)
CO3	Explain different issues in construction industries. (Cognitive Knowledge level: **Understand**)
CO4	Describe various hazards associated with different machines and mechanical material handling. (Cognitive Knowledge level: **Understand**)
CO5	Utilise different hazard identification tools in different industries with the knowledge of different types of chemical hazards. (Cognitive Knowledge level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2				2	2	2				1
CO2	2	1	2		1	1	1	1				1
CO3	2	2	2		1	1	1	1	1	1		1
CO4	2	2	2		1	1	1	1	1	1		1
CO5	2	2	2	1	1	1	1	1	1	1		1

Abstract POs defined by National Board of Accreditation			
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment - Test : 25 marks

Continuous Assessment - Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

MCN401- Industrial Safety Engineering (35 hrs)

Module I (safety introduction- 5 hrs)

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.

Module II (Personal protection in work environment- 7 hrs)

Personal protection in the work environment, Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.

Module III (safety issues in construction- 7 hrs)

Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.

Module IV (safety hazards in machines- 8 hrs)

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas

welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.

Module V (hazard identification and analysis- 8 hrs)

Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets (MSDS).

Text Books:

1. R.K Jain (2000) Industrial Safety, Health and Environment management systems, Khanna Publications.
2. Paul S V (2000), Safety management System and Documentation training Programme handbook, CBS Publication.
3. Krishnan, N.V. (1997). *Safety management in Industry*. Jaico Publishing House, New Delhi.
4. John V. Grimaldi and Rollin H.Simonds. (1989) *Safety management*. All India Traveller Book Seller, Delhi.
5. Ronald P. Blake. (1973). *Industrial safety.* Prentice Hall, New Delhi.
6. Alan Waring. (1996). *Safety management system*. Chapman & Hall, England.
7. Vaid, K.N., (1988). Construction safety management. National Institute of Construction Management and Research, Mumbai.

8. AIChE/CCPS. (1992). *Guidelines for Hazard Evaluation Proce*dures. (second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York.

Course Level Assessment Questions:

Course Outcome 1 (CO1):

1. Which are the various accident causation theories? Explain.
2. Define terms: Accident, Reportable accident, Dangerous occurrence.

Course Outcome 2 (CO2):

1. Discuss different types of personal protective equipment
2. Discuss about how to compare the safety performance of two industries.
3. Discuss the significance of work permit system in accident prevention.

Course Outcome 3 (CO3):

1. Distinguish ladders and scaffolds along with their safety features**.**
2. Discuss the safety requirement for a confined space entry.
3. Explain the important provision in the National Building Code.

Course Outcome 4 (CO4):

1. Explain the various principles used in machine guarding.
2. Explain the issues in mechanical material handling.

Course Outcome 5 (CO5):

1. Selection of different types of fire extinguishers accordance to type of fire.
2. Conduct a HAZOP study for a batch rector of your choice.
3. Determine different types of Chemical hazards associated with industries

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

VII SEMESTER B. TECH DEGREE EXAMINATION

MCN401- INDUSTRIAL SAFETY ENGINEERING

Maximum: 100 Marks **Duration: 3 hours**

PART A

Answer all questions, each question carries 3 marks

1. Differentiate Unsafe act and Unsafe conditions with suitable examples
2. Discuss the significance of a safety committee in improving the safety performance of an industry
3. Which are the different types of permit? Highlight its suitability.
4. Which are five 'S' used in housekeeping?
5. List the various safety features of ladders.
6. How safety of the workers can be ensured during a demolition operations.
7. Which are the hazards associated with manual material handling?
8. Discuss the safety issues of Gas welding operations.
9. Differentiate Hazard and Risk.
10. Why MSDS is mandatory for chemical products.

(10 X 3 = 30 Marks)

PART B

Answer one full question from each module

Module 1

11. List the various accident causation theories and explain any one in details. (14 Marks)
12. a) Discuss the significance of safety policy in reducing the accidents. (4 Marks)

    b) Safety and productivity are the two sides of a coin'. Are you agreeing with this statement? Explain with your arguments. (10 Marks)

Module 2

13. a) Classify the personal protective equipment. List the suitability of at least fifteen types of PPEs. (10 Marks)

b) How will you calculate the frequency rate? Explain with an example. (4 Marks)

14. a) How will you compare the safety performance of two industries? Explain with suitable example. (10 Marks)

    b) Which are the steps to be followed in confined space entry to protect the life a worker. (4 Marks)

Module 3

15. Discuss the safety and fire protection facilities required for a high rise building as per National building code. (14 Marks)

16. a) Identify the various hazards during the different stages of building construction. (7 Marks)

    b) Discuss the important types of ergonomic hazards associated with industries.(7 Marks)

Module 4

17. Which are the various types of machine guarding devices used industries. Discuss the suitability of each machine guarding devices. (14 Marks)

18. With suitable sketches briefly explain seven defects of wire ropes. (14 Marks)

Module 5

19. What is Hazard and Operability Analysis? How do you conduct a HAZOP analysis? (14 Marks)

20. Discuss about different types of chemical hazards. (14 Marks)

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures/ Tutorials L-T
1	**Introduction to Industrial safety Engineering**	
1.1	Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence. Reportable accidents	1
1.2	Theories of accident causation. Safety organization.	2
1.3	Role of management, supervisors, workmen, unions, government and voluntary agencies in safety.	3
1.4	Safety Officer-responsibilities, authority.	4
1.5	Safety committee-need, types, advantages.	5
2	**Personal protection in the work environment**	
2.1	Types of PPEs, respiratory and non-respiratory equipment.	6
2.2	Standards related to PPEs	7
2.3	Monitoring Safety Performance: Frequency rate, severity rate	8,
2.4	Monitoring Safety Performance: incidence rate, activity rate.	9
2.5	Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping.	10
2.6	Work permit system- objectives, hot work and cold work permits.	11
2.7	Typical industrial models and methodology. Entry into confined spaces.	12
3	**Introduction to construction industry and safety**	
3.1	Excavation and filling – Under-water works – Under-pinning & Shoring	13
3.2	Ladders & Scaffolds – Tunneling	14
3.3	Blasting –Demolition – Confined space	15
3.4	Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety.	16
3.5	Relevance of ergonomics in construction safety.	17
3.6	Ergonomics Hazards	18
3.7	Musculoskeletal Disorders and Cumulative Trauma Disorders.	19
4	**Machinery safeguard**	

MRT 413	NETWORK SECURITY	Category	L	T	P	Credits	Year of Introduction
		PEC	3	-	0	3	2019

Preamble:

The purpose of this course is to create a better understanding of the network security concepts. This course covers network security standards, email security services, web security mechanisms, firewalls and wireless security mechanisms. This course helps the learner to gain insight into the key aspects of secure network communication and enables to apply in real-life scenarios.

Prerequisite: A sound background in Number Theory and Cryptographic Algorithms.

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

CO#	Course Outcomes
CO1	Identify the key aspects of security, intrusion detection systems and digital signature schemes **(Cognitive Knowledge Level: Apply)**
CO2	Explain the security standards used in network communication (**Cognitive Knowledge Level:Understand)**
CO3	Identify the mechanisms in email security services (**Cognitive Knowledge Level: Apply)**
CO4	Summarize the protocols used to provide web security (**Cognitive Knowledge Level: Understand)**
CO5	Explain the fundamental concepts of wireless network security and firewalls **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓		✓						✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module – 1 (Network Security Basics)

Introduction to network security - Security requirements, Challenges of security, Network security model. Malicious programs – Worms, Viruses, Trojans, Spyware, Adware. Intrusion Detection Systems (IDS) - Uses, Techniques. Digital signatures - ElGamal, Schnorr, Digital Signature Standard (DSS).

Module – 2 (Network Security Standards)

Kerberos v4 – Configuration, Authentication, Encryption, Message formats. Kerberos v5 – Cryptographic algorithms, Message formats. Public Key Infrastructure (PKI) – Trust models, Revocation. Real-time communication security – Perfect Forward Secrecy (PFS), Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.

Module – 3 (Email Security)

Introduction to email security - Security services for email, Establishing keys, Privacy, Authentication, Message integrity, Non-repudiation. Privacy Enhanced Mail (PEM) – Encryption, Source authentication and integrity protection, Message formats. Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM. Pretty Good Privacy (PGP) - Encoding, Certificate and key revocation, Anomalies, Object formats.

Module – 4 (Web Security)

Introduction to web security - Web security considerations, Threats. Secure Sockets Layer (SSL) – Architecture, Protocols, Transport Layer Security (TLS) – Differences from SSL. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol.

Module – 5 (Wireless Network Security and Firewalls)

IEEE 802.11 Wireless LAN - Network components, Architectural model, Services. IEEE 802.11i wireless LAN security - Services, Phases of operation. Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2, Wireless Application Protocol (WAP) – Services, Protocol architecture. Firewalls – Need for firewalls, Packet filters, Circuit-level firewalls, Application layer firewalls.

Text Books

1. C. Kaufman, R. Perlman and M. Speciner, “Network Security: Private Communication in a Public World”, 2/e, PHI.
2. William Stallings, “Cryptography and Network Security Principles and Practice”, 5/e,Pearson Education Asia.

References

1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, “Cryptography and Network Security”, 3/e, Tata McGraw Hill.
2. Tyler Wrightson, “Wireless Network Security A Beginner’s Guide”, 2012, Tata McGraw Hill.
3. William Stallings, “Network Security Essentials: Applications and Standards”, 4/e, Prentice Hall.
4. Schiller J., Mobile Communications, 2/e, Pearson Education.
5. Roberta Bragg et. al., “Network Security: The Complete Reference”, Tata McGraw Hill.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Using the Schnorr digital signature scheme, let q = 83, p = 997 and d = 23. Find values for e_1 and e_2.
2. The Digital Signature Algorithm (DSA) specifies that if the signature generation process results in a value of zero, a new value of k should be generated and the signature should berecalculated. Give reason.

Course Outcome 2 (CO2):

1. In Kerberos v4, the authenticator field is not of security benefit when asking the Key Distribution Center (KDC) for a ticket for Bob, but useful when logging in as Bob. Give reasons for your answer.
2. How does the stateless cookie protocol provide clogging protection?

Course Outcome 3 (CO3):

1. If Alice is sending an ENCRYPTED message, she first signs the message digest with her private key and then encrypts the message digest with the pre-message secret key. Why this last encryption was considered necessary for encrypted messages and not for MIC-CLEAR or MIC-ONLY?
2. Which security services are considered desirable in the following cases? (i) Sending a purchase order (ii) Sending a ransom note. (iii) Sending a mission description to security officials.
3. Explain the security mechanism used in Gmail communication.

Course Outcome 4 (CO4):

1. Is it possible in SSL for the receiver to reorder SSL record blocks that arrive out of order? If so, how it can be done? If not, why?
2. Describe any five web security threats, their consequences and countermeasures.

Course Outcome 5 (CO5):

1. Explain the security areas addressed by IEEE 802.11i.
2. Describe the advantages and disadvantages of application layer firewalls.

Model Question Paper

QP CODE:

Reg. No:_____

Name:_____

PAGES : 3

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH. DEGREE (HONORS) EXAMINATION, MONTH &YEAR

Course Code: MRT 413

Course Name: Network Security

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Distinguish between signature-based and anomaly-based intrusion detection techniques.

2. A trusted third party is considered as a main component in a network security model. Why?

3. How is endpoint identifier hiding achieved in real-time communication?

4. Show how encryption is used to provide privacy and integrity in Kerberos v5.

5. End-to-end privacy is essential for e-mail security. How is this achieved?

6. List the four steps for preparing an EnvelopedData MIME entity.

7. Show the operation of a Secure Sockets Layer (SSL) Record protocol.

8. For Secure Shell (SSH) packets, what is the advantage of not including the MAC in the scope of packet encryption?

9. List the three security services provided by IEEE 802.11i.

10. Define the terms Access Point, Basic Service Set, Extended Service Set.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Using the ElGamal scheme, let p = 881 and d = 700, find values for e1 and e2. Choose r = 17. Find the value of S1 and S2 if M = 400. **(8)**

(b) Explain the requirements and challenges of network security. **(6)**

OR

12. (a) In ElGamal, Schnorr and DSS, what happens if an attacker can find the value of random secret key used by the signer? Also, what happens if a user uses the same value of random secret key to sign two messages? Explain your answer for each scheme separately. **(8)**

(b) Explain the network security model with the help of a neat diagram. **(6)**

13. (a) Alice wishes to log into Bob's workstation remotely. List the steps involved in this communication if Kerberos v4 is used. **(7)**

(b) How does Diffie-Hellman technique provide perfect forward secrecy using signature keys? **(7)**

OR

14. (a) Explain the algorithm for Message Authentication Code (MAC) calculation and verification in Kerberos v5 rsa-md5-des. **(8)**

(b) Compare the aggressive mode and main mode of Phase 1 Internet Key Exchange (IKE). **(6)**

15. (a) Describe the different methods by which authentication of source is performed in email communication. **(7)**

(b) Explain the Signed data and Clear-signed data functions provided by S/MIME. **(7)**

OR

16. (a) Explain the advantages of Pretty Good Privacy (PGP) over Privacy **(7)**

(b) Define non-repudiation. Describe the different ways by which it is implemented in email communication. **(7)**

17. (a) Describe the significance of pseudo-random function of Transport Layer Security. **(7)**

(b) Explain the four different phases of Secure Sockets Layer (SSL) HandshakeProtocol. **(7)**

OR

18. (a) Describe how connection initiation and connection closure is done in Hyper Text Transfer Protocol Secure (HTTPS). **(7)**

(b) Illustrate the sequence of events in Secure Shell (SSH) transport layer protocol packet exchanges. **(7)**

19. (a) Explain the Discovery phase and Authentication phase of IEEE 802.11i operation. **(7)**

(b) Why are firewalls needed? Compare the features of packet filters and circuit level firewalls. **(7)**

OR

20. (a) Explain the two authentication methods used in Wired Equivalent Privacy (WEP). **(7)**

(b) Describe the three transaction classes provided by Wireless Transaction Protocol. **(7)**

Enhanced Mail (PEM).

Teaching Plan

No	Contents	No of Lecture Hrs
Module - 1 (Network Security Basics) (7 hrs)		
1.1	Security requirements, Challenges of security	1
1.2	Network security model	1
1.3	Worms, Viruses, Trojans, Spyware, Adware	1
1.4	Intrusion Detection Systems (IDS) uses, Techniques	1
1.5	ElGamal digital signature	1
1.6	Schnorr digital signature	1
1.7	Digital Signature Standard (DSS)	1
Module - 2 (Network Security Standards) (10 hrs)		
2.1	Kerberos v4 configuration, Authentication	1
2.2	Kerberos v4 encryption	0.5
2.3	Kerberos v4 message formats	0.5
2.4	Kerberos v5 cryptographic algorithms – rsa-md5-des, des-mac, des-mac-k	1
2.5	Kerberos v5 cryptographic algorithms - rsa-md4-des, rsa-md4-des-k, Encryption for privacy and integrity	1
2.6	Kerberos v5 message formats	1
2.7	Public Key Infrastructure (PKI) trust models	0.5
2.8	PKI revocation	0.5
2.9	Perfect Forward Secrecy (PFS), Denial-of-Service protection	1
2.10	Endpoint identifier hiding, Live partner reassurance	1
2.11	Internet Protocol Security (IPSec) Authentication Header (AH), Encapsulating Security Payload (ESP)	1

2.12	Internet Key Exchange (IKE) phases	1
Module - 3 (Email Security) (8hrs)		
3.1	Security services for email, Establishing keys, Privacy	1
3.2	Authentication, Message integrity, Non-repudiation	0.5
3.3	Privacy Enhanced Mail (PEM) encryption, Source authentication	0.5
3.4	PEM integrity protection, Message formats (Lecture 1)	1
3.5	PEM message formats (Lecture 2)	1
3.6	Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM	1
3.7	Pretty Good Privacy (PGP) encoding, Certificate and key revocation, Anomalies	1
3.8	PGP Object formats (Lecture 1)	1
3.9	PGP Object formats (Lecture 2)	1
Module – 4 (Web Security)(8 hrs)		
4.1	Web security considerations, Threats, Secure Sockets Layer (SSL) architecture	1
4.2	SSL protocols (Lecture 1)	0.5
4.3	SSL protocols (Lecture 2)	0.5
4.4	Transport Layer Security (TLS) differences from SSL (Lecture 1)	1
4.5	TLS differences from SSL (Lecture 2)	1
4.6	Hypertext Transfer Protocol Secure (HTTPS) connection initiation, Closure	1
4.7	Secure Shell (SSH) transport layer protocol	1
4.8	SSH user authentication protocol	1
4.9	SSH connection protocol	1

Module - 5 (Wireless Security and Firewalls) (8 hrs)		
5.1	IEEE 802.11 Wireless LAN network components, Architectural model, Services	1
5.2	IEEE 802.11i wireless LAN security services, Phases of operation (Lecture 1)	1
5.3	IEEE 802.11i phases of operation (Lecture 2)	1
5.4	Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2	1
5.5	Wireless Application Protocol (WAP) services, Protocol architecture (Lecture 1)	1
5.6	WAP protocol architecture (Lecture 2)	1
5.7	Need for firewalls, Packet filters	1
5.8	Circuit-level firewalls, Application layer firewalls	1

MRT423	MICRO ELECTRO MECHANICAL SYSTEMS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims the students to learn about the introduction of MEMS and basic concepts of micromachining, scaling laws and miniaturization.

Prerequisite: NIL

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

CO 1	Explain MEMS, Microsystems.
CO 2	Apply MEMS in the field of automotive industries.
CO 3	Summarize different methods of packaging.
CO 4	Explain the application of scaling laws in the design of micro systems.
CO 5	Use MEMS processes for micromachining.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1					3						
CO 2					3	1		1				
CO 3	3				1							
CO 4		2	3					1				
CO 5	3		2			1						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum 2 subdivisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define Microsystems.

2. List the properties of materials for MEMS systems.

3. Explain physical effects of MEMS materials.

Course Outcome 2 (CO2)

1. Explain different techniques for Sensing and Actuation?

2. Explain actuators and actuated systems.

3. With suitable diagrams , explain electromagnetic actuations?

Course Outcome 3(CO3):

1. Brief different types of packaging for MEMS?

2. Explain about accelerated life modelling.

3. Describe different packaging considerations for MEMS.

Course Outcome 4 (CO4):

1. Explain about the Trimmer force scaling vector.

2. Explain various laws of scaling in miniaturization.

3. Derive the expression for electrostatic force and potential energy , with reference to the scaling laws of electrostatics.

Course Outcome 5 (CO5):

1. Explain anodic bonding with the help of neat diagrams.

2. Brief silicon direct bonding and Sol-Gel deposition methods.

3. Explain basic process tools for micro machining.

Model Question paper

QP CODE:

Reg. No:----------

Name: ----------

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH

DEGREE EXAMINATION, MONTH & YEAR

Course code: MRT 423 **Duration: 3hours**

MICRO ELECTRO MECHANICAL SYSTEMS

(2019- Scheme)

Mechatronics Branch

PART A

*(Answer **all** the questions, each question carries 3 marks)*

1. What is MEMS?
2. Explain oxide growth process in silicon with figures.
3. Brief thermal actuation.
4. Explain fluid nozzles.
5. Explain die-attach process.
6. Explain wire-bonding.
7. List various laws of scaling in miniaturization.
8. Explain laws of miniaturization in fluid mechanics.
9. Explain double sided lithography.
10. Explain isotropic wet-etching with diagrams.

PART B

*(Answer **one** full question from each module .each question carries 14 marks)*

Module 1

11.(a)	Explain any three properties of silicon carbide and silicon nitrate with reference to Microsystems.	(10 marks)
(b)	What are Shape Memory alloys?	(4 marks)
12.(a)	Explain the advantages of usage of polymers in micro systems. List different types of polymers. With examples.	(10 marks)
(b)	Explain any one method to produce single crystal silicon?	(4 marks)

Module 2

13.(a)	Explain any two methods of actuations.	(10 marks)
(b)	Brief about Capacitive Surface Micromachined Accelerometer.	(4 marks)
14.	Explain pressure sensors with neat diagrams.	(14 marks)

Module 3

15.(a)	Explain about various types of wires and interconnects.	(10 marks)
(b)	Describe ceramic packaging.	(4 marks)
16.	Explain about different packaging considerations.	(14 marks)

.Module 4

17.(a)	Explain scaling in fluid mechanics. What are the advantages of piezoelectric pumping?	(10 marks)
(b)	Explain trimmer force scaling vectors.	(4 marks)
18.	With reference to scaling of electrostatic forces, Derive the expression for electrostatic force and potential energy , which refers to the scaling laws of electrostatics.	(14 marks)

Module 5

19.(a)	Explain electrochemical etching and plasma etching.	(10 marks)
(b)	Explain DRIE.	(4 marks)
20.	Briefly explain Nonlithographic Microfabrication Technologies.	(14 marks)

Syllabus

Module 1

Micro electro mechanical system: MEMS and Microsystems – Micromachining. Materials for MEMS: Silicon-Compatible Material System- Other Materials and Substrates- Important Material Properties and Physical Effects.

Module 2

MEM Structures and Systems in Industrial and Automotive Applications: General Design Methodology -Techniques for Sensing and Actuation -Common Sensing Methods ,Common Actuation Methods -Passive Micromachined Mechanical Structures -Fluid Nozzles, Hinge Mechanisms - Sensors and Analysis Systems -Pressure Sensors, High-Temperature Pressure Sensors, Mass Flow Sensors, Acceleration Sensors, Angular Rate Sensors and Gyroscopes, Carbon Monoxide Gas Sensor - Actuators and Actuated Microsystems - Thermal Inkjet Heads, Micromachined Valves, Micropumps.

Module 3

Packaging and Reliability Considerations for MEMS : Key Design and Packaging Considerations - Wafer or Wafer-Stack Thickness -Wafer Dicing Concerns, Thermal Management, Stress Isolation, Protective Coatings and Media Isolation, Hermetic Packaging, Calibration and Compensation-- Die-Attach Processes - Wiring and Interconnects, Electrical Interconnects -Microfluidic Interconnects, Optical Interconnects -Types of Packaging Solutions - Ceramic Packaging, Metal Packaging, Moulded Plastic Packaging, Quality Control, Reliability, and Failure Analysis - Quality Control and Reliability Standards - Statistical Methods in Reliability, Accelerated Life Modelling, Major Failure Modes.

Module 4

Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics, Trimmer force scaling vector, scaling in electrostatic and electromagnetic forces, scaling in electricity and fluidic dynamics, scaling in heat conducting and heat convection.

Module 5

Processes for Micromachining: Basic Process Tools- Advanced Process Tools- Non-lithographic Micro fabrication Technologies- Combining the Tools—Examples of Commercial Processes- Poly-silicon Surface Micromachining, DRIE of SOI Wafers**.**

Text Books

1. N. Maluf, An Introduction to Microelectro Mechanical Systems Engineering, Artech House, 2000.
2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2002

Reference Books

1. Chang Liu, Foundations of MEMS, Pearson 2012

2. Julian W Gardner, Microsensors: Principles and Applications, John Wiley & Sons, 1994

3. Mark Madou, Fundamentals of Micro fabrication, CRC Press, New York, 1997

4. Stephen D. Senturia, Microsystem design, Springer (India), 2006.

5. Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Micro electro mechanical system:**	
1.1	MEMS and Microsystems – Micromachining.	1
1.2	Materials for MEMS: Silicon-Compatible Material System-	3
1.3	Other Materials and Substrates- Important Material Properties and Physical Effects	3
2	**MEM Structures and Systems in Industrial and Automotive Applications:**	
2.1	General Design Methodology -Techniques for Sensing and Actuation -	1
2.2	Common Sensing Methods, Common Actuation Methods -	1
2.3	Passive Micromachined Mechanical Structures -Fluid Nozzles, Hinge Mechanisms	1
2.4	Sensors and Analysis Systems -Pressure Sensors, High-Temperature Pressure Sensors, Mass Flow Sensors, Acceleration Sensors	1
2.5	Angular Rate Sensors and Gyroscopes , Carbon Monoxide Gas Sensor -	1
2.6	Actuators and Actuated Microsystems - Thermal Inkjet Heads, Micromachined Valves, Micropumps	2
3	**Packaging and Reliability Considerations for MEMS** :	
3.1	Key Design and Packaging Considerations - Wafer or Wafer-Stack Thickness -Wafer Dicing Concerns, Thermal Management, Stress Isolation, Protective Coatings and Media Isolation, Hermetic Packaging, Calibration and Compensation	1
3.2	Die-Attach Processes - Wiring and Interconnects, Electrical Interconnects -Microfluidic Interconnects, Optical Interconnects -	1
3.3	Types of Packaging Solutions - Ceramic Packaging, Metal Packaging, Molded Plastic Packaging	2
3.4	Quality Control, Reliability, and Failure Analysis	2
3.5	Quality Control and Reliability Standards - Statistical Methods in Reliability, Accelerated Life Modeling, Major Failure Modes.	1
4	**Scaling laws in miniaturization**	
4.1	Scaling in geometry, scaling in rigid body dynamics,	2
4.2	Trimmer force scaling vector	1
4.3	Scaling in electrostatic and electromagnetic forces	1
4.4	Scaling in electricity and fluidic dynamics	1
4.5	Scaling in heat conducting and heat convection.	1
5	**Processes for Micromachining**	
5.1	Basic Process Tools	1

5.2	Advanced Process Tools	1
5.3	Nonlithographic Microfabrication Technologies	2
5.4	Combining the Tools—Examples of Commercial Processes	1
5.5	Polysilicon Surface Micromachining, DRIE of SOI Wafers	2

MRT433	RENEWABLE ENERGY	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: Objective of this course is to inculcate in students an awareness of new and renewable energy sources.

Prerequisite: NIL.

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

CO 1	Choose the appropriate energy source depending on the available resources.
CO 2	Explain the concepts of solar thermal and solar electric systems.
CO 3	Illustrate the operating principles of wind, and ocean energy conversion systems.
CO 4	Outline the features of biomass and small hydro energy resources
CO 5	Describe the concepts of fuel cell and hydrogen energy technologies

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2					1	2					
CO 2	3											
CO 3	3					1	1					
CO 4	3					1	1					
CO 5	3											

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	25	25	50
Understand	20	20	40
Apply	5	5	10
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module, of which, students should answer any one. Each question can have a maximum of 2 subdivisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write short notes on the advantages and disadvantages of any three types of non-conventional energy sources.

2. What are the points to be considered while constructing a house for energy efficiency?

Course Outcome 2 (CO2)

1. Explain construction of solar flat plate collector with a neat diagram.

2. Draw the block diagram of a solar thermal electric plant and explain its working.

3. Discuss the effect of temperature and insolation on the characteristics of a solar cell. Draw the P-V characteristics of a Solar cell under varying temperature and irradiation level.

Course Outcome 3 (CO3):

1. Derive the expression for power in the wind turbine.

2. Classify tidal power plants and briefly explain any two of them.

3. With the help of a block diagram explain the working of a hybrid OTEC.

Course Outcome 4 (CO4):

1. What are the factors that affect biogas generation?

2. Compare the construction and performance of floating drum type and fixed dome type biogas plants with the help of neat sketches.

3. Discuss the selection criteria of turbines for a small hydro project.

Course Outcome 5 (CO5):

1. What is small hydro power? How is it classified? Obtain an expression for the power that can be generated from a small hydro power station.

2. Explain the hydrogen energy system with necessary diagrams.

3. What do you mean by the conversion efficiency of a fuel cell?

MODEL QUESTION

Total Pages:2

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: MRT433

Course Name: RENEWABLE ENERGY

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1 Differentiate between flat plate collectors and solar concentrators.

2 Discuss advantages and limitations of conventional energy sources.

3 With the help of a block diagram explain the working of a hybrid OTEC.

4 List out the advantages and disadvantages of a tidal power plant.

5 Discuss the different types of wind turbine rotors used to extract wind power.

6 The Danish offshore wind farm has a name plate capacity of 209.3 MW. As of January 2017 it has produced 6416 GWh since its commissioning 7.3 years ago. Determine the capacity factor of the above wind farm.

7 What are the factors that affect biogas generation?

8 Discuss the process of biomass to ethanol conversion

9 What are the components of a micro hydel power plant?

10 Enumerate the design and selection of different types of turbines used for small hydro plants.

PART B

Answer any one full question from each module. Each question carries 14 marks

Module 1

11 a) With the aid of a neat diagram, explain the working of a central tower collector type solar thermal electric plant. (9)

	b)	Define (i) Open Circuit Voltage (ii) Short circuit Current (iii) Fill factor and (iv) Efficiency of the solar cell	(5)
12	a)	Compare the components and working of a standalone and grid connected PV system.	(5)
	b)	How are energy resources classified? Compare conventional and non conventional sources of energy resources.	(9)

Module 2

13		What are the site selection criteria for OTEC? Draw the block diagram and explain the working of Anderson cycle based OTEC system. Explain how biofouling affects efficiency of energy conversion and how can it be minimised?	(14)
14		Explain the principle of operation of a tidal power plant. How it is classified? Draw the layout of a double basin tidal power plant and label all the components.Explain the function of each component	(14)

Module 3

15	a)	Prove that the maximum wind turbine output can be achieved when $V_d = \frac{1}{3}V_u$, where V_d V_d and $V_u V_u$ are down-stream and up-stream wind velocity respectively	(10)
	b)	What is pitch control of a wind turbine? Explain.	(4)
16	a)	Determine the power output of a wind turbine whose blades are 12m in diameter and when the wind speed is 6m/s, the air density is about 1.2kg/m^3 and the maximum power coefficient of the wind turbine is 0.35.	(5)
	b)	Explain the parts, their function and working of a wind power plant. What are the site selection criteria of a wind power plant?	(9)

Module 4

17	a)	With a neat schematic diagram, explain the biomass gasification based electric power generation system	(5)
	b)	Explain how urban waste is converted into useful energy.	(9)
18	a)	Compare the construction and performance of floating drum type and fixed dome type biogas plants with the help of neat sketches.	(10)
	b)	Explain the importance of biomass programmes in India.	(4)

Module 5

19	a)	Explain the operation of a phosphoric acid fuel cell with the help of a suitable diagram.	(7)
	b)	What are the different methods used for the production and storage of hydrogen	(7)
20	a)	Draw the layout of a mini hydro project and explain its working.	(7)
	b)	Describe the working and constructional features of PEM fuel cell	(7)

****

Syllabus

Module 1

Introduction, Classification of Energy Resources- Conventional Energy Resources - Availability and their limitations- Non-Conventional Energy Resources – Classification, Advantages, Limitations; Comparison.

SOLAR THERMAL SYSTEMS- Principle of Conversion of Solar Radiation into Heat – Solar thermal collectors. – Flat plate collectors. Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector).

SOLAR ELECTRIC SYSTEMS- Solar Thermal Electric Power Generation – Solar Photovoltaic – Solar Cell fundamentals - characteristics, classification, .construction. Solar PV Systems – stand-alone and grid connected- Applications .

Module 2

ENERGY FROM OCEAN- Ocean Thermal Energy Conversion (OTEC)- Principle of OTEC system- Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle. Site-selection criteria- Biofouling- Advantages & Limitations of OTEC.

TIDAL ENERGY – Principle of Tidal Power- Components of Tidal Power Plant (TPP)- Classification-single basin-double basin types –Limitations -Environmental impacts.

Module 3

WIND ENERGY- Introduction- Basic principles of Wind Energy Conversion Systems (WECS) wind speed measurement-Classification of WECS- types of rotors. wind power equation -Betz limit. Electrical Power Output and Capacity Factor of WECS- Advantages and Disadvantages of WECS -site selection criteria.

Module 4

BIOMASS ENERGY- Introduction- Biomass fuels-Biomass conversion technologies -Urban waste to Energy Conversion- Biomass Gasification- Biomass to Ethanol Production- Biogas production from waste biomass- factors affecting biogas generation-types of biogas plants – KVIC and Janata model-Biomass program in India.

Module 5

SMALL HYDRO POWER- Classification as micro, mini and small hydro projects - Basic concepts and types of turbines-selection considerations.

EMERGING TECHNOLOGIES: Fuel Cell-principle of operation –classification- conversion efficiency and losses - applications .Hydrogen energy -hydrogen production -electrolysis -thermo chemical methods -hydrogen storage and utilization.

Text Books

1. G. D. Rai, " Non Conventional Energy Sources", Khanna Publishers, 2010.
2. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 1999

Reference Books

1. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002
2. Earnest J. and T. Wizelius, Wind Power Plants and Project Development, PHI Learning, 2011.
3. Sab S. L., Renewable and Novel Energy Sources, MI. Publications, 1995.
4. Sawhney G. S., Non-Conventional Energy Resources, PHI Learning, 2012.
5. Tiwari G. N., Solar Energy- Fundamentals, Design, Modelling and Applications, CRC Press, 2002.
6. A.A.M. Saigh (Ed): Solar Energy Engineering, Academic Press, 1977
7. Abbasi S. A. and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, 2001..
8. Boyle G. (ed.), Renewable Energy - Power for Sustainable Future, Oxford University Press, 1996
9. Earnest J. and T. Wizelius, Wind Power Plants and Project Development, PHI Learning, 2011.
10. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 197
11. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978 62.
12. Khan B.H, Non Conventional Energy resources Tata McGraw Hill, 2009.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures (35 hours)
1	**Introduction (7 hours)**	
1.1	Classification of Energy Resources- Conventional Energy - Resources - Availability and their limitations	1
1.2	Non-Conventional Energy Resources – Classification, Advantages, Limitations, Comparison.	1
1.3	SOLAR THERMAL SYSTEMS- Principle of Conversion of Solar Radiation into Heat – Solar thermal collectors.	1
1.4	Flat plate collectors. Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector)	1
1.5	SOLAR ELECTRIC SYSTEMS- Solar Thermal Electric Power Generation	1
1.6	Solar Photovoltaic – Solar Cell fundamentals - characteristics, classification, construction.	1
1.7	Solar PV Systems – stand-alone and grid connected- Applications	1
2	**ENERGY FROM OCEAN (7 hours)**	
2.1	Ocean Thermal Energy Conversion (OTEC)- Principle of OTEC system-	1
2.2	Open Cycle (Claude cycle), Closed Cycle (Anderson cycle)	1
2.3	Hybrid cycle. Site-selection criteria	1
2.4	Biofouling- Advantages & Limitations of OTEC	1
2.5	TIDAL ENERGY – Principle of Tidal Power- Components of Tidal Power Plant (TPP)-	1
2.6	Classification-single basin- double basin types –Limitations and environmental impacts	2

3	**WIND ENERGY (7 hours)**	
3.1	Introduction- Basic principles of Wind Energy Conversion Systems (WECS)	1
3.2	Wind speed measurement	1
3.3	Classification of WECS- types of rotors	2
3.4	Wind power equation -Betz limit	1
3.5	Electrical Power Output and Capacity Factor of WECS	1
3.6	Advantages and Disadvantages of WECS -site selection criteria	1
4	**BIOMASS ENERGY (6 hours)**	
4.1	Urban waste to Energy Conversion	1
4.2	Biomass Gasification- Biomass to Ethanol Production	1
4.3	Biogas production from waste biomass	2
4.4	Types of biogas plants – KVIC and Janata model	1
4.5	Biomass program in India.	1
5	**SMALL HYDRO POWER (8 hours)**	
5.1	Classification as micro, mini and small hydro projects	1
5.2	Basic concepts and types of turbines- selection considerations.	2
5.3	EMERGING TECHNOLOGIES: Fuel Cell-principle of operation	1
5.4	Classification- conversion efficiency and losses - applications	1
5.5	Hydrogen energy -hydrogen production	1
5.6	Electrolysis -thermo chemical methods	1
5.7	Hydrogen storage and utilization.	1

MRT 433	**MANUFACTURING TECHNOLOGY**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		PEC	2	1	0	3

Preamble:

1. To understand basic manufacturing processes of casting and welding
2. Provide a detailed discussion on the welding process and the physics of welding.
3. To understand mechanisms of material removal in LBM and EBM process
4. To introduce the different forming process of forging, extrusion and drawing.
5. To introduce the different fabrication of microelectronic devices

Prerequisite: Knowledge of Material Science & Technology

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

CO 1	Illustrate the basic principles of foundry practices and special casting processes, their advantages, limitations and applications
CO 2	Categorize welding processes according to welding principle and material.
CO 3	Summarize the advantages of LBM and EBM over the fusion welding process.
CO 4	Explain the principles of the basic microelectronic processing technology.
CO 5	Summarize key aspects of the microelectronics industry and underlying processes in a manufacturing environment.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3											
CO 2												2
CO 3			3									
CO 4				3								
CO 5		3										

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	13	13	25
Understand	7	7	15
Apply	15	15	30
Analyse	5	5	10
Evaluate	5	5	10

Create	5	5	10

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain Why casting is an important manufacturing processes.
2. Name the important factors in selecting sand for molds.
3. Why does die casting produce the smallest cast parts?
4. What is the difference between sand-mold and shell mold casting?

Course Outcome 2 (CO2):

1. Describe the functions and characteristics of electrodes. What functions do coatings have? How are electrodes classified?
2. Describe the role of filler metals in welding.
3. Explain the significance of the stiffness of the components being welded on both weld quality and part shape

Course Outcome 3 (CO3):

1. What is the power of LBM and EBM used for welding?
2. Why LBM and EBM are better quality than fusion welding?
3. What is the HAZ of LBM as compared to the fusion welding process?

Course Outcome 4 (CO4):

1. Why is silicon the semiconductor most used in IC technology?
2. Define selectivity and isotropy and their importance in relation to etching.
3. Explain the differences between wet and dry oxidation.
4. How is epitaxy different from other techniques used for deposition? Explain?

Course Outcome 5 (CO5):

1. Describe bulk and surface micromachining.
2. Lithography produces projected shapes, so true three dimensional shapes are more difficult to produce. What lithography processes are best able to produce three-dimensional shapes, such as lenses? Explain.
3. Explain how you would produce a spur gear if its thickness was one-tenth of its diameter and its diameter was (a) 10 um, (b) 100 um, (c) 1 mm, (d) 10 mm, and (e) 100 mm.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

COURSE CODE: MRT 443

MANUFACTURING TECHNOLOGY

Mechatronics Branch

Duration: 3 hours

PART A

*(Answer **all** the questions, each question carries 3 marks)*

1. What are composite molds? Why are they used?
2. What are the advantages of pressure casting over other processes?
3. Describe what occurs to metal powders during sintering.
4. Explain the basic principles of arc-welding processes.
5. Are fluxes necessary in brazing? If so, why?
6. Soldering is generally applied to thinner components. Explain Why.
7. Why is control of the volume of the blank important in closed-die forging?
8. Define selectivity and isotropy and their importance in relation to etching.
9. Describe the difference between isotropic etching and anisotropic etching.
10. What is the difference between chemically reactive ion etching and dry-plasma etching (3 marks)

PART B

(Answer one full question from each module .each question carries 14 marks)

Module 1

11. Explain why squeeze casting produces parts with better mechanical properties, dimensional accuracy, and surface finish than do expendable-mold processes. (14 marks)
12. Explain different types of casting defects in detail. (14 marks)

Module 2

13 a. Explain the difference between impregnation and infiltration. Give some applications of each. (7 marks)
b. Describe the relative advantages and limitations of cold and hot isostatic pressing. (7 marks)

14 Explain the factors that contribute to the differences in properties across a welded joint. (14 marks)

Module 3

15 a. What are the principles of (a) wave soldering and (b) reflow soldering. (7 marks)
b. It is a common practice to tin-plate electrical terminals to facilitate soldering. Why is tin used? (7 marks)

16 Examine various household products and describe how their components are joined and assembled. Explain why those particular processes were used and not others. (14 marks)

Module 4

17 a. Describe the factors involved in precision forging. (7 marks)
b. Explain why cold extrusion is an important manufacturing process. (7 marks)

18 a. A common problem in ion implantation is channeling, in which the high-velocity ions travel deep into the material via channels along the crystallographic planes before finally being stopped. How could this effect be avoided? Explain. (7 marks)
b. Describe your understanding of the important features of clean rooms and how they are maintained. (7 marks)

Module 5

19 a. List the advantages and disadvantages of surface micromachining compared with bulk micromachining (7 marks).
b. What is the difference between chemically reactive ion etching and dry-plasma etching? (7 marks).

20 a. What is the main limitation to successful application of MEMS? (7 marks).
b. What is the purpose of a spacer layer in surface micromachining? (7 marks).

SYLLABUS

Module 1

Metal casting:- sand casting:- shell molding, evaporative pattern casting, investment casting, permanent mold casting, vacuum casting, slush casting, pressure casting, die casting, centrifugal casting, squeeze casting, semi solid metal forming, casting for single crystal, casting defects.

Module 2

Powder metallurgy:- powder production methods; powder characteristics; blending, mixing; compaction of metal powders; sintering fundamentals and mechanisms; infiltration and impregnation - Welding: arc welding: non consumable electrodes; heat affected zone; quality; case study and weldability of metals.

Module 3

Consumable electrodes; electron and laser beam welding; heat affected zone; power density; weld quality; case study; applications - Brazing:- filler metals, fluxes, joint strength; brazing methods, applications -Soldering:- solders and fluxes - soldering methods - solder ability, case study, typical joint designs, applications.

Module 4

Metal forging: quality, defects -Metal extrusion: process, defects, applications - Metal drawing process, drawing practice, defects, applications - Fabrication of microelectronic devices - crystal growing and wafer preparation - Film deposition - oxidation - Photo lithography

Module 5

Different lithography methods - Etching, wet etching, dry etching- diffusion and Ion implantation metallization and testing - wire bonding and packing - yield and reliability - fabrication of micro electro mechanical devices.

Text Books

1 Serope Kalpakjian, Steven R. Schmid - Manufacturing Engineering and Technology, seventh edition, Pearson.

Reference Books

1. https://nptel.ac.in/courses/103106075/
2. Principles of Metal Casting – Hine and Rosenthal
3. Materials and Processes in Manufacturing - Paul Degarma E and Ronald A. Kosher
4. Manufacturing Technology Foundry, Forming and Welding – P. N. Rao

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Metal casting -Sand casting:- sand, types of sand mold, pattern, cores, casting operations.	2
1.2	Shell molding, plaster and ceramic mold casting; evaporative pattern casting, investment casting,	2
1.3	Permanent mold casting, vacuum casting, slush casting, pressure casting, die casting,	1
1.4	Centrifugal casting, squeeze casting, semi solid metal forming - applications of each process	1
1.5	Casting for single crystal, applications of each process, casting defects	1
2	**Module 2**	
2.1	Powder metallurgy:-powder production methods, atomization, reduction, electrolytic deposition, carbonyls, comminution	2
2.2	Powder characteristics:- particle size, shape and distribution	1
2.3	Blending, mixing and compaction of metal powders, isostatic pressing	1
2.4	Sintering: fundamentals and mechanisms - infiltration and impregnation.	1
2.5	Welding: arc welding non consumable electrodes, heat transfer in arc welding, gas tungsten arc, plasma arc and atomic hydrogen welding; heat affected zone, weld ability, weld quality, applications of each process.	2
3	**Module 3**	
3.1	Consumable electrodes:-shielded metal, submerged, gas metal arc welding, heat affected zone, weld ability, weld quality, applications of each processes	2
3.2	Electron and laser beam welding, heat affected area, power density, weld quality, heat affected zone, case study, applications of each processes	1
3.3	Brazing:- filler metals, fluxes, joint strength; brazing methods, torch, furnace, induction, resistance, dip brazing, applications of each process.	2
3.4	Soldering:-types of solders and fluxes - different soldering methods - solder ability, case study, typical joint designs, applications of each process.	2
4	**Module 4**	

4.1	Metal forging:-open die, impression die, closed die, precision die, quality, defects	2
4.2	Metal extrusion:-process, hot, cold, impact and hydrostatic extrusion; defects, applications - Metal drawing process- drawing practice- defects, applications of each process.	3
4.3	Fabrication of microelectronic devices:-clean	2
5	**Module 5**	
5.1	Etching:- wet etching:- isotropic etchants, anisotropic etching - dry etching:-sputter, reactive plasma, physical chemical and cryogenic dry etching.	2
5.2	Diffusion and Ion implantation- metallization and testing- Wire bonding and packing-yield and reliability - printed circuit boards	2
5.3	Fabrication of micro electro-mechanical devices:- micromachining of MEMS devices: bulk and surface micro machining, single crystal silicon reactive etching and metallization, silicon micromachining by single step plasma etching, etching combined with diffusion bonding with suitable example and applications.	3

CODE	ENTREPRENEURSHIP	CATEGORY	L	T	P	CREDIT
MRT453		PEC	2	1	0	3

Preamble: Nil

Prerequisite: Nil

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

CO 1	Imbibe the spirit, roles, functions and fundamentals of entrepreneurship in a developing economy.
CO 2	Develop Proficiency in business plan preparation and detailed project report (DPR) preparation and ensure all round development of them.
CO 3	Familiarize with the ground realities of starting MSME units and opportunities available in the country.
CO 4	Analyze the operation and management of MSME units and develop motivation and entrepreneurial competency to start and run an enterprise successfully.
CO 5	Evaluate the scope of e-commerce and the challenges in entrepreneurship

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1		2	1	1								2
CO 2		3		1			1					2
CO 3		3	3	1								2
CO 4			2	1	2	2						2
CO 5		2		2								1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20

Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each full question carries 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Enumerate the importance of entrepreneurs.
2. What is the difference between an entrepreneur and a manager?

Course Outcome 2 (CO2)

1. What do you mean by business plan preparation?
2. What are the features of a joint venture?

Course Outcome 3(CO3):

1. How do you classify enterprises?
2. What are the concessions available for enterprises from the government side?

Course Outcome 4 (CO4):

1. What is the optimum size of plant in an MSME?
2. Give a detailed description of GST for enterprises.

Course Outcome 5 (CO5):

1. What do you mean by e-commerce?
2. What is social entrepreneurship?

Syllabus

Module 1

Introduction to Entrepreneurship-Types of entrepreneurs, Forms of business, Entrepreneurial Traits and competencies, Entrepreneur vs. Manager, Entrepreneur vs. Intrapreneur. Role of Entrepreneurship in Economic Development, Ethics and Social responsibility of Entrepreneurs. Opportunities for Entrepreneurs in India and abroad. Start-up India, Stand up India, National Skill Development Program, PMEGP, Mudra Yojana, and KVICschemes.

Module 2

The Entrepreneurial ideation and decision process. Incubation procedures and processes, Business plan preparation, DPR preparation. Managing Finance and Growth- Sources of capital, Venture capitalists, Angel Investors, Crowd Funding, Institutional financial assistance- Role of Financial Institutions and Commercial Banks for loans and financial controls. Features and evaluation of joint ventures, acquisitions, mergers, franchising, public issues, rights issues, bonus issues and stock splits.

Module 3

Micro, Small and Medium Enterprises - Importance, Evolution, Organisational Structure, Decision Making, Starting an MSME unit-phases, training requirements Extension Training Institute, Legal frameworks, Registration procedures, concessions and reliefs by Government.

Module 4

Production in MSME, Optimum Size of plant, Factors affecting production process, Production planning, Marketing and channel selection, control, product mix, DIN,TIN,PAN, GST Monitoring and evaluation of enterprise, Reasons for failures, Sickness in Small Scale Industries. Rehabilitation of sick units, Effective management of the enterprise.

Module 5

E-commerce and Entrepreneurship. Rural entrepreneurship, Social entrepreneurship. Challenges in entrepreneurship. Successful Entrepreneurs from the contemporary Indian business world- Success stories of great Indian Tycoons who have contributed to build the nation.

Text Books

1. Khanka SS: Entrepreneurial Development : S. Chand & Company Pvt.Ltd,Revised edition, 2012
2. Robert D.Hisrich, Mathew J Manimala, Michael P. Peters and Dean A. Shephered: Entrepreneurship: McGraw Hill Education India (P) Ltd, Chennai, 9e (2014)
3. Gita Piramal, Business Legends, Penguin Books

Reference Books

1. Bellon Whittington “Competing through Innovation” , Prentice Hall,2006.
2. Bhide, Amar V., “The Origin and Evolution of New Business”, OxfordUniversity Press, 2000
3. Charanthimath, Entrepreneurship development small business enterprises,Pearson Education, 2008
4. Dollinger M J, Entrepreneurship strategies and resources, Pearson Education,New Delhi2006

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	INTRODUCTION TO ENTREPRENEURSHIP	
1.1	Types of entrepreneurs, Entrepreneurial Traits and competencies	2 Hours
1.2	Ethics and Social responsibility of Entrepreneurs, Opportunities for Entrepreneurs in India and abroad.	3 Hours
1.3	Start-up India, Stand up India, National Skill Development Program, PMEGP, Mudra Yojana, and KVICschemes.	2 Hours
2	ENTREPRENEURSHIP IDEATION AND DECISION PROCESS	
2.1	Incubation procedures and processes, Business plan preparation, DPR preparation.	3 Hours
2.2	Managing Finance and Growth, Role of Financial Institutions and Commercial Banks for loans and financial controls.	2 Hours
2.3	Features and evaluation of joint ventures, acquisitions, mergers, franchising, public issues, rights issues, bonus issues and stock splits	2 Hours
3	MICRO SMALL AND MEDIUM ENTERPRISES	
3.1	Importance, Evolution, Organisational Structure	3 Hours
3.2	Decision Making, Starting an MSME unit - phases, training requirements,ExtensionTrainingInstitute,	2 Hours
3.3	Legal Frameworks,Registration procedures, concessions and reliefs by Government.	3 Hours
4	MSME PRODUCTION AND REHABILITATION OF SICK UNITS	
4.1	Production in MSME , Optimum Size of plant, Factors affecting production process, Production planning	3 Hours
4.2	Marketing and channel selection, control, product mix, DIN,TIN,PAN, GST Monitoring and evaluation of enterprise,	2 Hours
4.3	Reasons for failures, Sickness in Small Scale Industries. Rehabilitation of sick units, Effective management of the enterprise.	2 Hours
5	E-COMMERCE AND RURAL ENTREPRENEURSHIP	
5.1	E-commerce and Entrepreneurship.Rural entrepreneurship,	2 Hours
5.2	Social entrepreneurship.Challenges in entrepreneurship	2 Hours
5.3	Successful Entrepreneurs from the contemporary Indian business world	2 Hours

Model Question paper

QP CODE:

Reg. No:---------- **Name: ----------**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course code: MRT 453

ENTREPRENEURSHIP (2019- Scheme)

Mechatronics Branch

PART A

(Answer all the questions, each question carries 3 marks)

1. Differentiate between an Entrepreneur and Manager.
2. What are the social responsibilities of Entrepreneurs?
3. Define Merges and Acquisitions.
4. What do you mean by business plan preparation?
5. Define a MSME. What are its chief characteristics?
6. How do you classify enterprises?
7. Examine the significance of selection of optimum size of plant.
8. What are the incentives for enterprises?
9. Discuss the importance of rural entrepreneurship.
10. What is social entrepreneurship?

PART B

(Answer one full question from each module.each question carries 14 marks)

Module 1

11. Explain the features, advantages and disadvantages of Proprietorship, partnership, companies and cooperatives.

12. Write a note on the opportunities for Entrepreneurs in India and abroad.

Module 2

13. What are the sources of finance available to an entrepreneur in financing his venture? Explain their features and uses.

14. What is the role of Financial Institutions and Commercial Banks for loans and financial controls?

Module 3

15. Discuss the phases in starting an MSME unit.

16. Give a detailed account on the role of MSME in the molding of a successful entrepreneur. What are the challenges?

Module 4

17. Explain the common reasons for failure of an enterprise. Discuss a few methods for their rehabilitation.

18. What are the factors affecting the production in MSME?

Module 5

19. How is a social entrepreneur different from other entrepreneurs? How can social entrepreneurs attract and retain the right talent?

20. What is the role of e-commerce in entrepreneurship?

MRT 463	**FLUID MECHANICS AND MACHINERY**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		PEC	2	1	0	3

Preamble: Fundamental Concepts, fluid statics and dynamics, fluid kinematics, boundary layer theory, hydraulic turbines, positive displacement pumps, rotary motion of liquids, centrifugal pump, pumping devices.

Prerequisite: NIL

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

CO 1	Summarize the concepts of flow measurements and flow through pipes
CO 2	Apply the momentum and energy equations to fluid flow problems.
CO 3	Evaluate head loss in pipes and conduits.
CO 4	Apply the knowledge of working of different turbines to select the suitable type of turbine for an application
CO 5	Solve the centrifugal and reciprocating problems.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3											
CO 2	3	3										
CO 3	3	3										
CO 4	3											
CO 5	3											

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**

150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is meant by viscosity?
2. Explain the importance of viscosity in fluid motion

Course Outcome 2 (CO2):

1. The pressure at the Centre of a pipe of diameter 3m is 29.43N/cm2. The pipe contains an oil of sp. Gr. 0.87 and is fitted with a gate valve. Find the force exerted by the oil on the gate and position of Centre of pressure

Course Outcome 3(CO3):

1. Find the head loss due to friction in a pipe of diameter 250 mm and length 60m, through which water is flowing at a velocity of 3.0 m/s using (i) Darcy formula and Chezy's formula for which C= 55. Take Kinematic viscosity for water is 0.01 stoke, f=0.079/Re 1/4.

Course Outcome 4 (CO4):

1. A Kaplan turbine produces 60000KW under a head of 25m with an overall efficiency of 90%. Taking the value of speed ratio as 1.6, flow ratio as 0.5 and the hub diameter as 0.35 times the outer diameter; find the diameter and speed of the turbine

Course Outcome 5 (CO5):

1. A centrifugal pump delivers water against a net head of 14.5 meters and a design speed of 1000 r.p.m.The vanes are curved back to an angle of 300 with the periphery. The impeller diameter is 300 mm and outlet width is 50 mm. Determine the discharge of the pump if manometric efficiency is 95

Model Question paper

Reg. No: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR
COURSE CODE: MRT 463

Duration: 3 hours **FLUID MECHANICS AND MACHINERY**
Mechatronics Branch

PART A

*(Answer **all** the questions, each question carries 3 marks)*

1. Define the terms: (i) density (ii) specific gravity (iii) Ideal fluids.
2. Differentiate between compressible and incompressible fluids
3. Differentiate between Manometers and Pressure gauges.
4. What are the conditions of equilibrium of floating bodies?
5. Explain water hammer in pipes.
6. Distinguish between path lines, stream lines and streak lines.
7. Show that the maximum efficiency of a jet striking a single plate moving in the direction of the jet is 8/27.
8. Explain the uses of draft tube in turbines.
9. Explain the uses of Air vessels in reciprocating pumps.
10. Explain the importance of multistage pump.

PART B

(Answer one full question from each module. each question carries 14 marks)

Module 1

11. (a) What is meant by viscosity? Explain the importance of viscosity in fluid motion. (7 marks)
    (b) The velocity profile of a viscous fluid over a flat plate is parabolic with vertex 20 cm from the plate, where the velocity is 120 cm/s. Calculate the velocity gradient and shear stress at distances of 0,5, and 15 cm from the plate, given the viscosity of fluid = 6 poise (7 marks)
12. (a) Define surface tension. Obtain an expression for capillary rise of a liquid (7 marks)
    (b) A plate 0.025 mm distant from a fixed plate, moves at 60 cm/s and requires a force of 2 N per unit area, i.e. 2N/m2 to maintain this speed. Determine the fluid viscosity between the plates (7 marks)

Module 2

13 (a) State and prove Pascal's law (7 marks)
    (b) The right limb of a simple U-tube manometer containing mercury is open to the atmosphere while the left limb is connected to a pipe in which a fluid of sp.gr. 0.9 is flowing. The Centre of the pipe is 12 cm below the level of mercury in the right limb. Find the pressure of fluid in the pipe if the difference of mercury level in the two limbs is 20cm (7marks)
14 Derive an expression for the force exerted on a sub-merged plane surface by the static liquid and locate the position of Centre of pressure. (7 marks)

(b) The pressure at the Centre of a pipe of diameter 3m is 29.43N/cm2. The pipe contains an oil of sp. Gr. 0.87 and is fitted with a gate valve. Find the force exerted by the oil on the gate and position of Centre of pressure. (7 marks)

Module 3

15. (a) Define the equation of continuity. Obtain an expression for continuity equation for a three –dimensional flow (7 marks)
    (b) State Bernoulli's theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli's theorem from first principle and state the assumptions made for such a derivation. (7marks)
16. (a)Prove that the head loss due to friction is equal to one-third of the total head at inlet for maximum power transmission through pipes or nozzles (7marks)
    (b)Find the head loss due to friction in a pipe of diameter 250 mm and length 60m, through which water is flowing at a velocity of 3.0 m/s using (i) Darcy formula and Chezy's formula for which C= 55. Take Kinematic viscosity for water is 0.01 stoke, f=0.079/Re 1/4. (7 marks)

Module 4

17. (a)The water is flowing through a pipe of diameter 30 cm. The pipe is inclined and a venturimeter is inserted in the pipe. The diameter of venturimeter at throat is 15 cm. The difference of pressure between the inlet and throat of the venture meter is measured by a liquid of sp.gr.0.8 in an inverted U-tube which gives a reading of 40 cm. The loss of head between the inlet and throat is 0.3 times the kinetic head of the pipe. Find the discharge. (7 marks)
    (b) Obtain an expression for hydraulic efficiency of a pelton wheel turbine in terms of tangential velocity of bucket, jet velocity and vane angle at outlet. Proceed further to get the condition for maximum hydraulic efficiency. (7 marks)
18. A Kaplan turbine produces 60000KW under a head of 25m with an overall efficiency of 90%. Taking the value of speed ratio as 1.6, flow ratio as 0.5 and the hub diameter as 0.35 times the outer diameter; find the diameter and speed of the turbine. (7 marks)
    (b) Describe briefly the functions of various main components of Reaction turbine with neat sketches. (7marks)

Module 5

19. (a) What is priming. Why is it necessary (7marks)
    (b) A single acting reciprocating pump running at 30 r.p.m, delivers 0.012 m3/s of water. The diameter of the piston is 25 cm and stroke length is 50cm. Determine: (i) The theoretical discharge of the pump, (ii) Co-efficient of discharge and (iii) Slip and percentage slip of the pump (7marks)

20. (a)Define indicator diagram. What is the effect of acceleration in suction and delivery pipes on indicator diagram? (7marks)
    (b)A centrifugal pump delivers water against a net head of 14.5 meters and a design speed of 1000 r.p.m.The vanes are curved back to an angle of 300 with the periphery. The impeller diameter is 300 mm and outlet width is 50 mm. Determine the discharge of the pump if manometric efficiency is 95% (7marks)

SYLLABUS

Module 1

Fundamental concepts: Properties of fluid - density, specific weight, viscosity, surface tension, capillarity, vapour pressure, bulk modulus, compressibility, velocity, rate of shear strain, Newton's law of viscosity, Newtonian and non-Newtonian fluids, real and ideal fluids, incompressible and compressible fluids.

Module 2

Fluid statics: Atmospheric pressure, gauge pressure and absolute pressure. Pascal's Law, measurement of pressure - piezo meter, manometers, pressure gauges, energies in flowing fluid, head - pressure, dynamic, static and total head, forces on planar and curved surfaces immersed in fluids, centre of pressure, buoyancy, equilibrium of floating bodies, metacentre and metacentric height.

Module 3

Fluid kinematics and dynamics: Classification of flow -1D, 2D and 3D flow, steady, unsteady, uniform, non-uniform, rotational, irrotational, laminar and turbulent flow, path line, streak line and stream line. Continuity equation, Euler's equation, Bernoulli's equation. Reynolds experiment, Reynold's number. Hagen- Poiseuille equation, head loss due to friction, friction, Darcy-Weisbach equation, Chezy's formula, compounding pipes, branching of pipes, siphon effect, water hammer transmission of power through pipes (simple problems)

Module 4

Flow rate measurements- venturi and orifice meters, notches and weirs (description only for notches, weirs and meters), practical applications, velocity measurements- Pitot tube and Pitot –static tube. Hydraulic turbines: Impact of jets on vanes - flat, curved, stationary and moving vanes - radial flow over vanes. Impulse and Reaction Turbines – Pelton Wheel constructional features - speed ratio, jet ratio & work done , losses and efficiencies, inward and outward flow reaction turbinesFrancis turbine constructional features, work done and efficiencies – axial flow turbine (Kaplan) constructional features, work done and efficiencies, draft tubes, surge tanks, cavitation in turbines.

Module 5

Positive displacement pumps: reciprocating pump, indicator diagram, air vessels and their purposes, slip, negative slip and work required and efficiency, effect of acceleration and friction on indicator diagram (no derivations), multi cylinder pumps. Rotary motion of liquids: – free, forced and spiral vortex flows, (no derivations), centrifugal pump, working principle, impeller, casings, manometric head, work, efficiency and losses, priming, specific speed, multistage pumps, selection of pumps, pump characteristics

Text Books

1. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002.

2. Kumar D. S., Fluid Mechanics and Fluid Power Engineering, S. K. Kataria& Sons, New Delhi, 1998.

Reference Books

1. J. F. Douglas, "Fluid Mechanics", Pearson education.

2. Cengel Y. A. and J. M. Cimbala, Fluid Mechanics, Tata McGraw Hill, 2013

3. Robert W. Fox and Mc Donald, “Introduction to fluid dynamics”, John Wiley and sons

4. K. Subrahmanya, “Theory and applications of fluid mechanics”, (TMH)

5. Shames. I. H, “Mechanics of fluids”.

6. JagadishLal, “Fluid mechanics and Hydraulic machines”.

7. R K Bansal, “Hydraulic Machines

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Fundamental concepts: Properties of fluid - density, specific weight,	1
1.2	viscosity, surface tension	1
1.3	capillarity, vapour pressure	1
1.4	bulk modulus, compressibility	1
1.5	velocity, rate of shear strain, Newton's law of viscosity	1
1.6	Newtonian and non-Newtonian fluids, real and ideal fluids, incompressible and compressible fluids.	2
2	**Module 2**	
2.1	Fluid statics: Atmospheric pressure, gauge pressure and absolute pressure. Pascal's Law	2
2.2	measurement of pressure - piezo meter, manometers, pressure gauges	1
2.3	Energies in flowing fluid, head - pressure, dynamic, static and total head,	1
2.4	Forces on planar and curved surfaces immersed in fluids, centre of pressure,	1
2.5	buoyancy, equilibrium of floating bodies, metacentre and metacentric height	2
3	**Module 3**	
3.1	Fluid kinematics and dynamics: Classification of flow -1D, 2D and 3D flow, steady, unsteady, uniform, non-uniform, rotational, irrotational, laminar and turbulent flow	2
3.2	path line, streak line and stream line.	1
3.3	Continuity equation, Euler's equation, Bernoulli's equation.	1
3.4	Reynolds experiment, Reynold's number.	1
3.5	Hagen- Poiseuille equation, head loss due to friction, friction, Darcy-Weisbach equation, Chezy's formula	1
3.6	compounding pipes, branching of pipes, siphon effect, water hammer transmission of power through pipes (simple problems)	1
4	**Module 4**	
4.1	Flow rate measurements- venturi and orifice meters, notches and weirs (description only for notches, weirs and meters), practical applications,	2
4.2	Velocity measurements- Pitot tube and Pitot –static tube.	1
4.3	Hydraulic turbines: Impact of jets on vanes - flat, curved, stationary and moving vanes - radial flow over vanes. Impulse and Reaction Turbines – Pelton Wheel constructional features	2
4.4	speed ratio, jet ratio & work done, losses and efficiencies,	1

4.5	inward and outward flow reaction turbines Francis turbine constructional features, work done and efficiencies	1
4.6	Axial flow turbine (Kaplan) constructional features, work done and efficiencies, draft tubes, surge tanks, cavitation in turbines	1
5	**Module 5**	
5.1	Positive displacement pumps: reciprocating pump, indicator diagram	1
5.2	Air vessels and their purposes, slip, negative slip and work required and efficiency, effect of acceleration and friction on indicator diagram (no derivations)	1
5.3	Multi cylinder pumps.	1
5.4	Rotary motion of liquids: – free, forced and spiral vortex flows, (no derivations)	1
5.5	Centrifugal pump, working principle, impeller, casings, manometric head, work, efficiency and losses, priming, specific speed,	1
5.6	Multistage pumps, selection of pumps, pump characteristics	1

MRT473	MAINTENANCE ENGINEERING AND MANAGEMENT	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble

This course helps the students to understand the concept of engineering behind maintenance. It is also expected to throw light on the different maintenance strategies and failure analysis tools and also associate the tools and techniques related to maintenance and its management scenarios in an industry.

Prerequisite

Nil

Course outcomes

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

CO 1	Understand the concept of maintenance and reliability and their inter-relationship; and develop reliability of a system based on its configuration. (Cognitive knowledge level: **Apply**)
CO 2	Understand the different types and strategies of maintenance (Cognitive knowledge level: **Understand**)
CO 3	Understand the different techniques used in condition monitoring (Cognitive knowledge level: **Understand**)
CO 4	Understand the tools, strategies and methods for assessing and ensuring effective maintenance (Cognitive knowledge level: **Understand**)
CO 5	Apply planning, scheduling, costing& budgeting in maintenance and preparation of maintenance budget. (Cognitive knowledge level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	1	1	1							
CO 2	2	2	1	1								
CO 3	2	2	2	2	3							1
CO 4	2	3	2	3	1	1				1	1	2
CO 5	2	1	2	1	1	1			1	1	2	1

Strong – 3 **Medium - 2** **Weak - 1**

Assessment pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	Test 1	Test 2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	Continuous Internal Evaluation	End Semester Examination	End Semester Examination Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course level assessment questions

Course outcome 1 (co1)

1. Explain the need for maintenance in an industry.
2. Explain MTBF.
3. Explain Maintainability and Availability.

Course Outcome 2 (CO2)

1. What are the main factors which determine the selection of a maintenance system for an industry.
2. List out the merits and demerits of corrective maintenance strategy.
3. Compare Breakdown maintenance and Preventive maintenance.

Course Outcome 3 (CO3)

1. Explain how performance monitoring can be used for an effective condition monitoring.
2. Explain how internal leakages can be detected.
3. Describe the different types of corrosion monitoring techniques.

Course Outcome 4 (CO4)

1. Explain the procedure of FTA.
2. Compare FMEA and FMECA.
3. Define OEE.

Course Outcome 5 (CO5)

1. Illustrate the importance of maintenance planning with the help of an example.
2. Compare between Formal and Informal maintenance system.
3. Explain the importance of maintenance training.

Model question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B. TECH DEGREE EXAMINATION

COURSE CODE: MRT 473
COURSE NAME: MAINTENANCE ENGINEERING AND MANAGEMENT

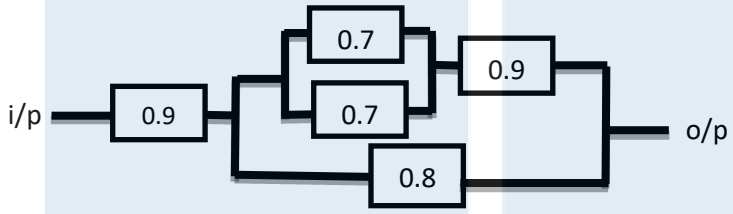
Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

(10x3=30 marks)

1) List the objectives of maintenance.
2) Determine the system reliability of the system given below, given reliability of each component.



3) What are the main benefits of reactive maintenance?
4) List the main factors which determine the selection of a maintenance system for an industry?
5) What is leakage monitoring?
6) Why crack monitoring is important in maintenance perspective?
7) Define OEE.
8) List the merits of conducting ETA.
9) List the objectives of maintenance training.
10) List the advantages of Computer aided maintenance management system (CMMS).

PART B

Answer any one full question from each module. Each full question carries 14 Marks

Module 1

11) (a) Explain basic and composite functions of Maintenance. (7 marks)
(b) Explain the various causes of failures. (7 marks)

OR

12) (a) Describe bathtub curve of a product in maintenance context (7 marks)
(b) Explain MTTF. How is it assessed? (7 marks)

Module 2

13) (a) Explain the classification of maintenance strategies. (7 marks)
(b) Differentiate between Offline and Online condition monitoring. (7 marks)

OR

14) (a)List out the merits and demerits of corrective maintenance strategy. (7 marks)
(b)Compare Breakdown maintenance and Preventive maintenance. (7 marks)

Module 3

15) (a) Explain how performance monitoring can be used for an effective condition monitoring. (7 marks)

(b)Explain any three different methods for crack monitoring in a metal piece. (7 marks)

OR

16) (a)List and explain the principle and operation of any two vibration transducers. (7 marks)

(b)How condition monitoring is done using vibration analyser. Give two examples of this application. (7 marks)

Module 4

17) (a)Define FMECA. Compare it with FMEA. (7 marks)
(b) Explain the procedure of FTA. (7 marks)

OR

18) (a)What all targets can be achieved in an industry by implementing TPM? (7 marks)
(b) Explain the concept of DMAIC. (7 marks)

Module 5

19) (a)What are the classifications of maintenance cost? List and explain. (7 marks)
(b) What are the hurdles of maintenance budgeting? (7 marks)

OR

20) (a)Explain the structure of Functional Maintenance Organisation. (7 marks)
(b)Describe the need for maintenance planning in detail. (7 marks)

SYLLABUS

Module 1: Maintenance and Reliability concepts (7 hours)

Maintenance - need/purpose, basic and composite functions of maintenance. Principles, objectives and benefits of maintenance. Defects and failures – definitions – basics of failures, sources of defects, failure rate, causes and types of failures. Reliability – basic concepts – bathtub curve. System reliability – reliability of series, parallel and mixed systems (simple problems), basics concepts of Standby redundant systems, shared load systems and Redundancy techniques used in system design (unit, component, weakest link and mixed Techniques). MTTF, MTBF, MTTR, MTBM, Maintainability, Availability, Inter-relationship between productivity, quality, reliability, availability and maintainability in maintenance.

Module 2: Maintenance strategies and classifications (7 hours)

Maintenance strategies/systems/types – classifications, basis/factors considered for selection. Breakdown maintenance, Corrective maintenance –concept, features. Routine Maintenance and Opportunistic maintenance – concept, features. Proactive maintenance – concept, features. Preventive maintenance – basics. Predictive maintenance – basics, advantages and disadvantages. Condition based maintenance - features. Merits and demerits of maintenance strategies.

Module 3: Condition monitoring concepts in CBM (7 hours)

Condition monitoring in CBM – monitoring systems (offline and online) and techniques/methods. Performance monitoring and visual monitoring. Leakage monitoring, detection of leakages. Temperature monitoring, Thermography – features, advantages and limitations. Thickness monitoring – methods, Acoustic/Noise monitoring, smell/odour monitoring. Vibration monitoring – vibration fundamentals, causes and detection. Vibration transducers – types, vibration measuring/monitoring equipment. Lubricant monitoring – techniques. Ferrography and Spectroscopy – basics, particle counter techniques. Crack monitoring – techniques. Corrosion monitoring – techniques.

Module 4: Tools, strategies and methods for effective maintenance (7 hours)

Reliability centred maintenance (RCM) and its advantages. Failures, Failure modes and failure density – definitions, reasons/mechanisms of failures – Failure/Fault analysis (Logical and Sequential fault location methods). Fault tree analysis (FTA) – steps, features and merits. Event tree analysis (ETA) – features, merits and procedure. Root cause analysis (RCA), Cause and Effect analysis. Failure modes and effects analysis (FMEA). Failure mode Effect and Criticality Analysis (FMECA).Six sigma maintenance – DMAIC. Lean maintenance concept – features and benefits. 5-Zero maintenance concept, 5-S maintenance concept. Maintenance effectiveness – Overall Equipment Effectiveness (OEE) – Key Performance Indicators/Maintenance performance measuring indices – Quality, Performance and Cost based indices (definitions and basic equations).

Module 5: Maintenance Planning, Scheduling, Cost and Budgeting (7 hours)

Maintenance Planning, Procedure/steps in maintenance planning. Maintenance Scheduling - basic techniques. Maintenance Organization – factors affecting size and type of maintenance organization – objectives and characteristics. Types of maintenance organisation – Formal and Informal organisation, Classifications of maintenance organisation – Line & Staff, Functional, Centralized and Decentralized maintenance organisation – Merits and Demerits. Maintenance costs – classification of maintenance costs – maintenance cost analysis. Maintenance Budget – types of maintenance budget – preparation of maintenance budget (basics). Maintenance Spares Management. Maintenance Training – need, objectives, methods and benefits.

Text Books

1. Gupta A. K. (2015). Reliability, Maintenance and Safety Engineering, 1st edition, Laxmi Publications.
2. Rao S. S. (1992). Reliability-Based Design, McGraw-Hill.
3. Srivastava, S.K. (2010). Maintenance Engineering and Management, 1st edition, S. Chand.
4. Venkataraman. (2007). Maintenance Engineering and Management, Prentice-Hall.

Reference Books

1. Brumbach, M., Clade, J. (2013). *Industrial Maintenance*, 2nd edition, Delmar Cengage Learning
2. Davies, A. (1998). *Handbook of Condition Monitoring: Techniques and Methodology*, Springer.
3. Mishra R.C., Pathak, K. (2012). *Maintenance Engineering and Management*, 2nd edition, PHI Learning.
4. Mobley, K. (2014). *Maintenance Engineering Handbook*, 8th edition, McGraw-Hill.

Additional Web Reference Material

1. NPTEL, *NOC: Machinery Fault Diagnosis and Signal Processing*, IIT Kharagpur. https://nptel.ac.in/courses/112/105/112105232/
2. IIT Kharagpur, *Virtual Lab: Vibration Monitoring of Machineries by Wireless Technique, Module-3.* http://vlabs.iitkgp.ac.in/mssp/exp9/index.html

Course contents and lecture schedule

No	Topic	No. of Lectures (hours)
Module 1: Maintenance and Reliability Concepts (7 hours)		
1.1	Maintenance - need/purpose, basic and composite functions of maintenance. Principles, objectives and benefits of maintenance.	1
1.2	Defects and failures – definitions – basics of failures, sources of defects, failure rate, causes and types of failures.	1
1.3	Reliability – basic concepts, Bathtub curve	1
1.4	System reliability – reliability of series, parallel and mixed systems (simple problems)	1
1.5	Basic concepts of Standby redundant systems, shared load systems and Redundancy techniques used in system design (unit, component, weakest link and mixed Techniques).	1
1.6	MTTF, MTBF, MTTR, MTBM, Maintainability, Availability	1
1.7	Inter-relationship between productivity, quality, reliability, availability and maintainability in maintenance.	1
Module 2: Maintenance Strategies and Classifications (7 hours)		
2.1	Maintenance strategies/systems/types – classifications, basis/factors considered for selection of maintenance strategy	1
2.2	Breakdown maintenance – Features, Advantages and disadvantages.	1
2.3	Corrective maintenance – concept, features, Advantages and disadvantages.	1
2.4	Routine Maintenance and Opportunistic maintenance – concept, features, Advantages and disadvantages	1
2.5	Proactive maintenance and Preventive maintenance – concept, features, Advantages and disadvantages	1
2.6	Predictive maintenance – basics, advantages and disadvantages.	1
2.7	Condition based maintenance – features, Merits and demerits	1
Module 3: Condition monitoring concepts in CBM (7 hours)		
3.1	Condition monitoring in CBM – monitoring systems (offline and online) and techniques/methods.	1
3.2	Performance monitoring and visual monitoring. Leakage monitoring, detection of leakages.	1
3.3	Temperature monitoring,Thermography – features, advantages and limitations.	1
3.4	Thickness monitoring – methods, Acoustic/Noise monitoring, smell/odour monitoring.	1
3.5	Vibration monitoring – vibration fundamentals, causes and detection. Vibration transducers – types, vibration measuring/monitoring equipment.	1
3.6	Lubricant monitoring – techniques. Ferrography and Spectroscopy – basics, particle counter techniques.	1
3.7	Crack monitoring – techniques. Corrosion monitoring – techniques	1
Module 4: Tools, strategies and methods for effective maintenance (7 hours)		
4.1	Reliability centred maintenance (RCM) and its advantages. Failures, Failure modes and failure density – definitions, reasons/mechanisms of failures	1
4.2	Failure/Fault analysis (Logical and Sequential fault location methods). Fault tree analysis (FTA) – steps, features and merits.	1
4.3	Event tree analysis (ETA) – features, merits and procedure.	1
4.4	Root cause analysis (RCA), Cause and Effect analysis.	1
4.5	Failure modes and effects analysis (FMEA). Failure mode Effect and Criticality Analysis (FMECA).	1

No	Topic	No. of Lectures (hours)
4.6	Six sigma maintenance – DMAIC. Lean maintenance concept – features and benefits. 5-Zero maintenance concept, 5-S maintenance concept.	1
4.7	Maintenance effectiveness – Overall Equipment Effectiveness (OEE) – Key Performance Indicators/Maintenance performance measuring indices – Quality, Performance and Cost based indices (definitions and basic equations).	1
Module 5:	**Maintenance Planning, Scheduling, Cost and Budgeting** (7 hours)	
5.1	Maintenance Planning, Procedure/steps in maintenance planning. Maintenance Scheduling - basic techniques.	1
5.2	Maintenance Organization – factors affecting size and type of maintenance organization – objectives and characteristics.	1
5.3	Types of maintenance organisation – Formal and Informal organisation	1
5.4	Classifications of maintenance organisation – Line & Staff, Functional, Centralized and Decentralized maintenance organisation – Merits and Demerits.	1
5.5	Maintenance costs – classification of maintenance costs – maintenance cost analysis.	1
5.6	Maintenance Budget – types of maintenance budget – preparation of maintenance budget (basics). Maintenance Spares Management.	1
5.7	Maintenance Training – need, objectives, methods and benefits	1
Total		**35 hours**

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MRT 415	BASICS OF ROBOTICS & AUTOMATION	CATEGORY	L	T	P	CREDIT
		OE	2	1	0	3

Preamble: This course aims at imparting knowledge about robotics as well as automation. This will include basics of robots, sensors, kinematics as well as control and industrial automation.

Prerequisite: NIL

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

CO 1	Explain robot actuators and controls
CO 2	Summarize robot sensors for robotic application
CO 3	Explain the kinematics of robots and adaptive control
CO 4	Understand the basics of Programming Logic Circuits
CO 5	Acquire proficiency in programming Programmable Logic Circuits

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1		1								
CO 2	3	2	1	2								2
CO 3	3	3										
CO 4	3	3	2	2								2
CO 5	3	2										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum 2 subdivisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. How do you classify robotic structures?
2. Define roll, pitch and yaw.
3. Which are the drives used in Robotics?

Course Outcome 2 (CO2):

1. What is the necessity of sensors in robotics?
2. Why is machine vision a superior sensor in robotics?
3. Mention a few sensors used in robotics.

Course Outcome 3 (CO3):

1. What do you mean by forward kinematics?
2. Explain the inverse kinematics of robots.
3. What is the advantage of adaptive control structures?

Course Outcome 4 (CO4):

1. What is a PLC?
2. What is a ladder program? What are its components?
3. Explain the architecture of PLC.

Course Outcome 5 (CO5):

1. What are the advantages and capabilities of a PLC
2. Explain a PLC based system for automation
3. Explain alarms and interlocks.

Model Question paper

QP CODE:

Reg. No: _____ **Duration: 3 hours**

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

COURSE CODE: MRT 415

BASICS OF ROBOTICS & AUTOMATION

Mechatronics Branch

PART A

*(Answer **all** the questions, each question carries 3 marks)*

1. What are the advantages of PLC over electromechanical relay control? (3 marks)
2. With a suitable example explain latching in PLC Ladder logic. (3 mark)
3. What is the scope of industrial automation? (3 mark)
4. What are the applications of Motion Actuators? (3 mark)
5. Differentiate between a serial and parallel robot. (3 marks)
6. Write a short note on encoders. (3 marks)
7. Write a short note on Force-Torque sensors. (3 marks)
8. Draw and explain the components and structure of the robotic arm? (3 marks)
9. When will hydraulic drive be preferred in robots? (3 marks)
10. Explain the common kinematic arrangements of robots based on various coordinate System? (3 marks)

PART B

(Answer one full question from each module. each question carries 14 marks)

Module 1

11. Explain different types of stepper motor. (14 marks)
12. With illustrations, explain the basic robotic configurations. (14 marks)

Module 2

13 Explain different types of robot End effectors? (14 marks)

14 Illustrate the working principle of various position sensors used in a robotic system? . (14 marks)

Module 3

15 Explain the structure of robot programming language (14 marks)

16 Explain about joint angle, joint distance, link length and link twist with the help of D-H representation. (14 marks)

Module 4

17 (a) Illustrate the architecture of PLC? (8 marks)
(b)What are the different types of PLC? (6 marks)

18 What are the advantages and capabilities of a PLC? (14 marks)

Module 5

19 Explain a PLC based system for automation. Explain its ladder diagram. (14 marks)

20 (a) Explain the requirements of the communication system in a PLC. (4 marks)
(b) Illustrate the importance of Alarms and Interlocks in a PLC program. (10 marks)

SYLLABUS

Module 1

Robotics –Introduction –Basic Structure-Classification of Robot and Robotic System-Law of Robotics-Robot Motion-Wrist Configuration-Motion – Roll –Pitch-Yaw-Drives-Hydraulic Motors-DC Motor-Stepper Motor-Power Transmission Systems.

Module 2

Sensors in Robotics: Position Sensor-Potentiometer-Encoders-LVDT-Velocity Sensor-Acceleration Sensor-Force-Pressure and Torque Sensor-Touch and Tactile Sensor-Proximity –Range and Sniff Sensor-Robot End Effectors-Types of End Effectors- Mechanical Gripper –Types of Gripper Mechanism.

Module 3

Position Orientation-Frames-Mapping-Changing Description from Frames to Frames. Transformation arithmetic's - Translation-rotation-transformation- transforms equations- transformation of the vectors-. Introduction to manipulations Forward Kinematics and inverse Kinematics- D-H representation-Method of Robotic Programming (Qualitative Treatment Only).

Module 4

Basics of PLC-Advantage- Capabilities of PLC-Architecture of PLC- Scan Cycle-Types of PLC-Types of I/O Modules-Configuring of PLC –PLC wiring.

Module 5

Simple process control programme using ladder logic- PLC arithmetic functions- Timer and Counters-Data transfer-comparison and manipulation instructions-Interlocks and Alarms-Requirement of communication networks in PLC – connecting PLC to computer.

Text Books

1. M.P Groover, Industrial Robotics-Technology, Programming and Applications, McGraw-Hill USA, 1986
2. John Craig, "Introduction to Robotics", Macmillan, 1985
3. Curtis Johnson Process Control Instrumentation Tech 8 TH Edition Prentice Hall June 2005
4. Petrezeulla, Programmable Controllers, McGraw Hills, 1989

Reference Books

1. D Roy Choudhury and shaail B. jain, Linear Integrated circuits New age international Pvt.Ltd 2003
2. Boltans w. "Mechatronics" Pearson Education ,

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Robotics: Introduction**	
1.1	Basic Structure- Law of Robotics	1
1.2	Classification of Robot and Robotic System	1
1.3	Robot Motion	1
1.4	Wrist Configuration-Motion – Roll –Pitch-Yaw	1
1.5	Drives-Hydraulic Motors	1
1.6	DC Motor	0.5
1.7	Stepper Motor	0.5
1.8	Power Transmission Systems	1
2	**Sensors in Robotics**	
2.1	Position Sensor-Potentiometer-Encoders-LVDT-	0.5
2.2	Velocity Sensor	0.5
2.3	Acceleration Sensor	1
2.4	Force-Pressure and Torque Sensor	1
2.5	Touch and Tactile Sensor	1
2.6	Proximity –Range and Sniff Sensor	1
2.7	Robot End Effectors	0.5
2.8	Types of End Effectors	0.5
2.9	Mechanical Gripper –Types of Gripper Mechanism	1
3	**Robotics Kinematics**	
3.1	Description-Position	0.5
3.2	Orientation-Frames- Mapping	0.5
3.3	Changing Description from Frames to Frames.	0.5
3.4	Translation-rotation-transformation	0.5
3.5	Transformation arithmetic's- transforms equations	1
3.6	transformation of the vectors	1
3.7	Introduction to manipulations Forward Kinematics and inverse Kinematics	1
3.8	D-H representation	1
3.9	Method of Robotic Programming (Qualitative Treatment Only).	1
4	**Basics of PLC**	
4.1	Advantage of PLC	1
4.2	Architecture of PLC	2
4.3	Scan Cycle-Types of PLC	1
4.4	Types of I/O modules	1
4.5	Configuring of PLC	1
4.6	PLC wiring	1

5	**PLC programming**	
5.1	Simple process control programme using ladder logic	1
5.2	PLC arithmetic functions- Timer and Counters	1
5.3	Data transfer	1
5.4	comparison and manipulation instructions	1
5.5	Interlocks and Alarms	1
5.6	Requirement of communication networks in PLC	1
5.7	connecting PLC to computer	1

MRL 411	CAD LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble:

This course will introduce the student to the entry level applications of design software and experience to create 3D Models of Basic Parts and Assemblies, Orthographic Drawings, and perform a Generative Design on Parts & Assemblies.

Prerequisite: EST 110 – Engineering Graphics

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

CO 1	Construct a 2D Part Sketch
CO 2	Create a 3D Part Model
CO 3	Create a 3D Assembly
CO 4	Gain knowledge in creating solid machinery parts with animation

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	-	-	-	3	-	-	-	3	-	-	3
CO 2	3	-	-	-	3	-	-	-	3	-	-	3
CO 3	3	-	3	-	3	-	-	-	3	-	-	3
CO 4	3	-	3	-	3	-	-	-	3	-	-	3

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern:

End semester examination shall be conducted on modelling, assembly and animation based on a ***single question***.
The following general guidelines should be maintained for the award of marks
(a) Creation of part drawing : 25 Marks
(b) Creation of assembly : 25 Marks
(c) Creating animation of the design : 15 Marks
(d) Viva voce : 5 marks
(e) Record : 5 Marks

General instructions: Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Create 2D drawings of a shaft bearing from a 3D figure using CAD software

Course Outcome 2 (CO2):

1. How to make a robotic gripper using CAD software

Course Outcome 3 (CO3):

1. Create a universal joint assembly using CAD software

.

Course Outcome 4 (CO4):

1. Create a robotic arm and give the proper movements using CAD software
2. Produce an industrial robot design, assembly, and animation using CAD software.
3. Make a piston and connecting rod design, assembly, and animation using CAD software

LIST OF EXPERIMENTS : (Minimum 12 exercises is mandatory)

1. Creation of 2D drawings from 3D model (minimum 4 models. Questions for examinations must not be taken from this portions)
2. Creation of part drawings (3D figures of at least 4 models)
3. Making of assembly drawings & creating animation of a design (at least 4 figures)

Text Books

1. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill, 2007
2. Mikell P. Groover and Emory W. Zimmer, CAD/ CAM – Computer Aided Design and Manufacturing, Pearson Education,1987

Reference Books

1. Autodesk Fusion 360 :A power guide for beginners and intermediate users by John Willis, Sandeep Dogra,Cadartifex, 2018
2. Beginner's guide to solid works 2022 – Level I: Parts,Assemblies,Drawings,Photoview 360 and simulationXpress , 1st edition by Alejandro Reyes

MRQ413	SEMINAR	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: The course 'Seminar' is intended to enable a B.Tech graduate to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

Course Objectives:

- To do literature survey in a selected area ofstudy.
- To understand an academic document from the literate and to give a presentation about it.
- To prepare a technical report.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

CO1	Identify academic documents from the literature which are related to her/his areas of interest (Cognitive knowledge level: **Apply**).
CO2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest (Cognitive knowledge level: **Analyze**).
CO3	Prepare a presentation about an academic document (Cognitive knowledge level: **Create**).
CO4	Give a presentation about an academic document (Cognitive knowledge level: **Apply**).
CO5	Prepare a technical report (Cognitive knowledge level: **Create**).

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1		2	1					3
CO2	3	3	2	3		2	1					3
CO3	3	2			3			1		2		3
CO4	3				2			1		3		3
CO5	3	3	3	3	2	2		2		3		3

Abstract POs defined by National Board of Accreditation MECHATRONICS			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

General Guidelines

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a student, all members of IEC shall be present.
- Formation of IEC and guide allotment shall be completed within a week after the University examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

Evaluation pattern

Total marks: 100, only CIE, minimum required to pass 50

Seminar Guide: 20 marks (Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

Seminar Coordinator: 20 marks (Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation: 40 marks to be awarded by the IEC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report: 20 marks to be awarded by the IEC (check for technical content, overall quality, templates followed, adequacy of references etc.).

MRD415	PROJECT PHASE I	CATEGORY	L	T	P	CREDIT
		PWS	0	0	6	2

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problemsolving.
- To foster innovation in design of products, processes orsystems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
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PROJECT PHASE I

Phase 1 Target

- Literature study/survey of published literature on the assigned topic
- Formulation of objectives
- Formulation of hypothesis/ design/ methodology
- Formulation of work plan and task allocation.
- Block level design documentation
- Seeking project funds from various agencies
- Preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility study
- Preparation of Phase 1 report

Evaluation Guidelines & Rubrics

Total: 100 marks (Minimum required to pass: 50 marks).

- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.
- Project Phase - I Report (By Evaluation Committee): 20 Marks.

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor).

Evaluation by the Guide

The guide/supervisor shall monitor the progress being carried out by the project groups on a regular basis. In case it is found that progress is unsatisfactory it shall be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Topic Selection: innovativeness, social relevance etc. (2)

Problem definition: Identification of the social, environmental and ethical issues of the project problem. (2)

Purpose and need of the project: Detailed and extensive explanation of the purpose and need of the project. (3)

Project Objectives: All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified. (2)

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (3)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (7)

EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-a	Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment) [CO1]	10	The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet.	The team has identified a topic. The originally selected topic lacks substance and needs to be revised. There were suggestions given to improve the relevance and quality of the project topic. Only a few relevant references were consulted/ studied and there is no clear evidence to show the team's understanding on the same. Some objectives identified, but not clear enough.	Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity, however some objectives are not realistic enough.	The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real world problem and is potentially innovative. The group shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-b	Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment) [CO4]	10	No evidence of planning or scheduling of the project. The students did not plan what they were going to build or plan on what materials / resources to use in the project. The students do not have any idea on the budget required. The team has not yet decided on who does what. No project journal kept.	Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members.	Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement.	Excellent evidence of enterprising and extensive project planning. Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials / resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done. All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide. Each member knows well about their individual tasks.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
Phase 1 Interim Evaluation Total Marks: 20						

EVALUATION RUBRICS for PROJECT Phase I: Final Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-c	Formulation of Design and/or Methodology and Progress. (Group assessment) [CO1]	5	None of the team members show any evidence of knowledge about the design and the methodology adopted till now/ to be adopted in the later stages. The team has not progressed from the previous stage of evaluation.	The students have some knowledge on the design procedure to be adopted, and the methodologies. However, the team has not made much progress in the design, and yet to catch up with the project plan.	The students are comfortable with design methods adopted, and they have made some progress as per the plan. The methodologies are understood to a large extent.	Shows clear evidence of having a well-defined design methodology and adherence to it. Excellent knowledge in design procedure and its adaptation. Adherence to project plan is commendable.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
1-d	Individual and Teamwork Leadership (Individual assessment) [CO3]	10	The student does not show any interest in the project activities, and is a passive member.	The student show some interest and participates in some of the activities. However, the activities are mostly easy and superficial in nature.	The student shows very good interest in project, and takes up tasks and attempts to complete them. Shows excellent responsibility and team skills. Supports the other members well.	The student takes a leadership position and supports the other team members and leads the project. Shows clear evidence of leadership.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-e	Preliminary Analysis/ Modeling / Simulation/ Experiment / Design/ Feasibility study [CO1]	10	The team has not done any preliminary work with respect to the analysis/modeling/ simulation/experiment/desig n/feasibility study/ algorithm development.	The team has started doing some preliminary work with respect to the project. The students however are not prepared enough for the work and they need to improve a lot.	There is some evidence to show that the team has done good amount of preliminary investigation and design/ analysis/ modeling etc. They can improve further.	Strong evidence for excellent progress in the project. The team has completed the required preliminary work already and are poised to finish the phase I in an excellent manner. They have shown results to prove their progress.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

1-f	Documentation and presentation. (Individual & group assessment). [CO6]	5	The team did not document the work at all. The project journal/diary is not presented. The presentation was shallow in content and dull in appearance. The individual student has no idea on the presentation of his/her part.	Some documentation is done, but not extensive. Interaction with the guide is minimal. Presentation include some points of interest, but overall quality needs to be improved. Individual performance to be improved.	Most of the project details were documented well enough. There is scope for improvement. The presentation is satisfactory. Individual performance is good.	The project stages are extensively documented in the report. Professional documentation tools like LaTeX were used to document the progress of the project along with the project journal. The documentation structure is well-planned and can easily grow into the project report. The presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
Total		**30**	**Phase - I Final Evaluation Marks: 30**			

EVALUATION RUBRICS for PROJECT Phase I: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-g	Report [CO6]	20	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly Unacknowledged content. Lack of effort in preparation is evident.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report.	Project report shows evidence of systematic documentation. Report is following the standard format and there are only a few issues. Organization of the report is good. Most of references are cited properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows standard styles.
			(0 - 7 Marks)	(8 - 12 Marks)	(13 - 19 Marks)	(20 Marks)
Phase - I Project Report Marks: 20						