

APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

SEMESTER V

KTU



MUT301	AUTO ELECTRICAL AND ELECTRONICS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims at providing

1. Knowledge regarding the basic wiring of an automobile
2. Knowledge about the construction and working of batteries
3. Knowledge about the working of charging, starting systems and lighting systems
4. Knowledge about the need and working of ignition systems.
3. To know the different types, automotive sensors and actuators.
4. A basic idea on the engine management systems and vehicle management systems

Prerequisite: AUTO POWER PLANT, AUTO CHASSIS

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

CO 1	Distinguish the different types of batteries, its working principle, construction and applications
CO 2	Categorize the charging systems and starting systems in vehicles
CO 3	Identify the ignition system and lighting systems used in vehicles
CO 4	Understand the different types of sensors used in vehicles
CO 5	Illustrate and identify the engine management system and vehicle management systems

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3hours

Continuous Internal Evaluation Pattern:

Attendance :10 marks
 Continuous Assessment Test(2numbers): 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 construction and working of lead acid battery?
2. What type of battery is used in electric vehicles?
3. What are the various battery tests

Course Outcome 2 (CO2)

1. Explain the working of Starter motor
2. Explain the construction and working of alternator

3. What are the components that make up the charging system in an automobile? State the purpose of each

Course Outcome 3(CO3):

1. What is the importance of ignition timing in an SI engine?
2. Explain the working of lighting system in automobiles
3. What are the various other lights used in automobiles other than head light?
4. What are the various gauges used in automobiles?

Course Outcome 4 (CO4):

1. Explain the working of Hall effect sensor?
2. Explain how the engine crankshaft position is determined using the Crankshaft Position Sensor
3. What are the different types of actuators used in automobiles? State the application

Course Outcome 5 (CO5):

1. What is the difference between GDI and MPFI?
2. What are the various sensors used in fuel injection system?
3. What are the important vehicle management systems used in automobiles?



Model Question paper

QP CODE:

PAGES: 2

Reg. No: _____

Name : _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MUT301

Course Name: AUTOMOTIVE ELECTRICAL AND ELECTRONICS

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all Questions.

Each question carries 3 Marks (2 questions from each module)

1. What is the purpose of cut-out relay in a charging system?
2. what is the purpose of specific gravity test and HRD test?
3. What are the different types of starting drives and starting switches?
4. What is the working principle of alternator?
5. Why centrifugal and vacuum advance mechanism is needed?
6. What is the purpose of flasher unit? How it works?
7. What is Lambda Sensor? Define Lambda
8. What type of actuator is used in injector? Explain
9. What is the role of Engine Management system?
10. What is the difference between cruise control system and traction control system?

PART B

Answer any one full question from each module.

Each question carries 14 Marks

Module 1

11. What are the various battery tests conducted to access the state of charge of battery? Explain any three tests. (14)

Or

12. Explain the constructional details of Lead Acid battery with necessary sketches. (14)

Module 2

13. a) Explain the working principle of alternator with a sketch (7)
b) Explain about half-wave and full wave rectification with neat sketch. (7)

Or

14. a) Explain construction and working of Bendix drive (7)
b) How solenoid shift cum relay works? Explain with diagram (7)

Module 3

15. a) Explain about the spark plug and its constructional details (7)
b) With a neat sketch Explain the working of an electric horn. (7)

Or

16. Describe a high-tension magneto ignition system with figure and state its advantages and disadvantages. (14)

Module 4

17. Explain the working of MAP sensor and Throttle position sensor used in automobile with the help of sketch. (14)

Or

18. a) Explain about the application of position and lambda sensors used in automobile with neat sketches. (7)
b) Explain about the function of wheel speed sensors with neat sketch. (7)

Module 5

19. Explain the construction and working of CRDI system with a sketch. What is quadra jet and Multijet injection? Explain (14)

Or

20. Explain the constructional features of ABS with a sketch. State the different types of ABS
What are the advantages of ABS

SYLLABUS

Module 1

Principle and construction of Lead Acid Battery, Nickel – Cadmium Battery, Lithium ion Battery, Lithium Phosphate Battery, LTO Battery, Nickel Metal , Sodium Sulphur Battery and Aluminum Air Battery.

Characteristics of Battery, Battery Rating, Capacity and Efficiency, Various Tests on Battery, Battery– Charging Techniques. Maintenance of batteries.

Module 2

Charging Systems

Charging system components, Generators and Alternators, types, construction and Characteristics, Voltage and Current Regulation, Cut –out relays and regulators, Charging circuits for D.C. Generator

Starting System

Requirements of Starter Motor, Starter Motor types, construction and characteristics, Starter drive mechanisms, Starter Switches and Solenoids.

Module 3

Ignition Systems

Conventional Type -Battery Coil and Magneto–Ignition System Circuit details and Components, Spark Plugs- Constructional details and Types, Centrifugal and Vacuum Advance Mechanisms, Non–Contact–type Ignition Triggering devices, Capacitive Discharge Ignition, Distributor–less Ignition System.

Lighting System

Head Lamp and Indicator Lamp construction and working details, Focusing of head lamps, Anti-dazzling devices, Automotive Wiring Circuits (Horn Circuit, Indicator Lamp Circuit, Electronic Fuel Gauge, oil pressure gauge, Coolant temperature indicator.)

Module 4

Sensors and Actuators:

Speed sensors, Pressure sensors: Manifold Absolute Pressure sensor, knock sensor, Temperature sensors: Coolant and Exhaust gas temperature, Exhaust Oxygen level sensor. Position sensors: Throttle position sensor, accelerator pedal position sensor and crankshaft position sensor, Air mass flow sensor. Solenoids, stepper motors and relays

Module 5**Engine Management System:**

Electronic engine control :Electronic fuel control system, Typical Control for a fuel injection system, MPFi And CRDI System, EGR control

Electronic ignition systems – Spark advance correction schemes, fuel injection timing control

Vehicle Management Systems

Cruise control system, Antilock braking system, electronic suspension system, electronic steering control, traction control system, Transmission control system

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	STORAGE BATTERY	
1.1	Principle and construction of Lead Acid Battery	1
1.2	Nickel – Cadmium Battery, Lithium-ion Battery, Lithium Phosphate Battery	2
1.3	LTO Battery, Nickel Metal, Sodium Sulphur Battery and	2
1.4	Aluminum Air Battery. Characteristics of Battery, Battery Rating, Capacity and Efficiency,	2
1.5	Various Tests on Battery, Battery– Charging Techniques. Maintenance of batteries	2
2	CHARGING AND STARTING SYSTEM	
2.1	Charging Systems Charging system components,	1
2.2	Generators and Alternators, types, construction and Characteristics,	2
2.3	Voltage and Current Regulation, Cut –out relays and regulators, Charging circuits for D.C. Generator	2
2.4	Starting System Requirements of Starter Motor, Starter Motor types, construction and characteristics,	2
2.5	Starter drive mechanisms, Starter Switches and Solenoids.	2
3	IGNITION AND LIGHTING SYSTEM	
3.1	Ignition Systems Conventional Type -Battery Coil and Magneto–Ignition System Circuit details and Components,	2
3.2	Spark Plugs- Constructional details and Types, Centrifugal and Vacuum Advance Mechanisms,	2

3.3	Non-Contact-type Ignition Triggering devices, Capacitive Discharge Ignition, Distributor-less Ignition System.	2
3.4	Lighting System Head Lamp and Indicator Lamp construction and working details, Focusing of head lamps, Anti-dazzling devices,	2
3.5	Automotive Wiring Circuits (Horn Circuit, Indicator Lamp Circuit, Electronic Fuel Gauge, oil pressure gauge, Coolant temperature indicator.)	2
4	SENSORS AND ACTUATORS	
4.1	Speed sensors, Pressure sensors: Manifold Absolute Pressure sensor, knock sensor,	3
4.2	Temperature sensors: Coolant and Exhaust gas temperature, Exhaust Oxygen level sensor. Position sensors: Throttle position sensor,	3
4.3	accelerator pedal position sensor and crankshaft position sensor, Air mass flow sensor. Solenoids, stepper motors and relays	3
5	ENGINE AND VEHICLE MANAGEMENT SYSTEM	
5.1	Engine Management System: Electronic engine control :Electronic fuel control system, Typical Control for a fuel injection system,	3
5.2	MPFi And CRDI System, EGR control Electronic ignition systems – Spark advance correction schemes, fuel injection timing control	3
5.3	Vehicle Management Systems Cruise control system, Antilock braking system, electronic suspension system,	2
5.4	electronic steering control, traction control system, Transmission control system	2

AUT303	MANUFACTURING PROCESS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: The aim of this subject is to offer the students a general understanding of various manufacturing process.

- ✓ To understand the basic concept of foundry and casting, metal forming and welding.
- ✓ To know different defects formed in the manufacturing process.
- ✓ To select the proper manufacturing process for the given applications.
- ✓ To select the non-traditional machining process for the given applications.
- ✓ To understand the basics of advanced manufacturing technology.

Prerequisite: Nil

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

CO 1	Understand the basic concept of foundry and casting
CO 2	Explain the different types of Metal joining process
CO 3	Discuss the different metal forming process
CO 4	Explain the non-conventional machining process
CO 5	Explain the advanced manufacturing technology

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	-	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	1	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	25	25	50
Understand	25	25	50
Apply			
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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Explain the basic concept of foundry and casting
2. Explain Applications of Casting.

Course Outcome 2 (CO2)

1. Explain the metal Joining processes.
2. Differentiate between the soldering & brazing

Course Outcome 3(CO3):

1. Discuss the metal forming process.
2. Explain the Forging & Rolling process
3. Explain the Extrusion process.

Course Outcome 4 (CO4):

1. Explain the non-conventional machining process
2. Explain the Laser Beam, Plasma Arc Machining Electro Chemical Machining, Ultrasonic Machining,
3. Explain Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining, Electron Discharge Machining and Plasma Arc Machining.

Course Outcome 5 (CO5):

1. Discuss the Advanced Manufacturing Techniques.
2. Explain the Micro machining
3. Explain the Rapid prototyping & Nano technology

Model Question paper

QP CODE:

PAGES: 3

Reg. No: _____

Name : _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: AUT303

Course Name: MANUFACTURING PROCESS

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all Questions.

Each question carries 3 Marks (2 questions from each module)

1. Discuss shell mould casting, mention its advantages and disadvantage
2. Explain the basic steps involved in casting process.
3. What is the principle of plasma? Explain plasma arc welding
4. You are assigned to join 'Rails' by Indian railways. Explain the suitable welding process with neat sketch.
5. Explain deep drawing operation with neat sketch and mention the importance of die clearance
6. What do you understand by the term 'forging'? Explain the following (i) Open die forging (ii) Closed-die forging
7. Explain the principle and working of Electro Chemical Grinding (ECG) process with suitable diagram.

8. Explain Abrasive Jet Machining (AJM) process and its process parameters
9. What is rapid prototyping? Explain in detail (i) Selective Laser Sintering (SLS) (ii) Stereolithography (SLA)
10. What is nano Technology? Give details about its applications in various fields

PART B

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

Module 1

11. Explain the construction and working principle of cupola furnace.

Or

12. Explain the vacuum casting process with figure

Module 2

13. Explain Tungsten Inert Gas (TIG) welding in detail.

Or

14. a. Compare soldering and brazing processes
- b. List the advantages and disadvantages

Module 3

15. a. What are the classifications of extrusion process?
- b. Explain any two extrusion types in detail.

Or

16. Discuss the principle and mechanism of rolling with suitable figure.

Module 4

17. a. Explain with a neat sketch the principle and working of Ultrasonic Machining (USM) process.
- b. List its advantages, disadvantages and applications.

Or

18. What is the principle of Electron Beam Machining (EBM)? Explain the process in details.

Module 5

19. a. What is microfabrication technology?
b. Explain (i) Micro cutting (ii) Micro finishing

Or

20. a. State the main factors that affect the selection of a manufacturing process.
b. Explain (i) Process Information Maps (ii) Elimination and Ranking Strategy

SYLLABUS

Module 1

CASTING: Steps involved in making a casting – Advantage of casting and its applications. Patterns and Pattern making – Types of patterns – Materials used for patterns, core and core making, casting design considerations. Casting processes - Sand, CO₂ moulding; shell moulding, investment moulding, permanent mould casting, pressure die casting, centrifugal casting, continuous casting. Methods of Melting: Crucible melting and cupola operation, Defects in casting.

Module 2

WELDING: Classification of welding processes. Principles of Oxy-acetylene gas welding. A.C Metal-arc welding, Resistance welding, Submerged arc welding, Tungsten inert gas welding, Metal inert gas welding, plasma arc welding, Thermit welding, Electron beam welding, Laser beam welding, defects in welding, soldering and brazing.

Module 3

FORMING AND SHAPING OF PLASTICS: Blanking and piercing – Bending and forming Rolling, Theory of Rolling, Types of Rolling mills. Drawing and its types – wire drawing and Tube drawing – coining – Hot and cold spinning Basic extrusion processes and its characteristics. Forging processes - Principles of forging, tools and dies - Types of forging – Open, closed, drop forging, roll forging.

Module 4

Non-Traditional Machining Processes: Need for non-traditional machining, Principle, equipment & operation of Laser Beam, Plasma Arc Machining, Electro Chemical Machining, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining, Electron Discharge Machining and Plasma Arc Machining.

Module 5

Advanced manufacturing techniques –Material addition process: 3D Printing- stereo-lithography, selective laser sintering, fused deposition modelling, laminated object manufacturing, laser engineered net-shaping, LIGA process. Sustainable and green manufacturing Application of

Nano Technology. Manufacturing process capabilities – process selection factors process information maps – ranking strategy

Text Books

1	Manufacturing Engineering and Technology,	Kalapakjian and Schmid	Pearson, 7e, 2013
2	Introduction to Manufacturing Processes	Schey A John	Tata McGraw Hill, Noida, 2012
3	Elements of Workshop Technology Vol:1	S.K Hajra Choudhury,A. K Hajra Choudhury Nirjhar Roy	Media Promoters & Publishers Pvt. Ltd.

Reference Books

4	Principles of Metal Casting	Heine, Loper and Rosenthal	Tata McGraw Hill Publishing Co, Ltd; New Delhi, 2011.
5	Foundry Engineering	Banga T.R; and Agrawal R.L	Khanna Publishers, New Delhi, 2007
6	Manufacturing Technology (materials, processes and equipments)	Helmi A Youssef, Hassan A El-Hofy and Mahmoud H Ahmed,	CRC Press, 2017

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	CASTING Module 1 (9 hours)	
1.1	Steps involved in making a casting Advantage of casting and its applications	1
1.2	Patterns and Pattern making – Types of patterns – Materials used for patterns	2
1.3	Core and core making, casting design considerations.	2
1.4	Casting processes - Sand, CO2 moulding; shell moulding, investment moulding, permanent mould casting, pressure die casting, centrifugal casting, continuous casting	2

1.5	Methods of Melting: Crucible melting and cupola operation Defects in casting.	2
2	WELDING: Module 2 (9 hours)	
2.1	Classification of welding processes	1
2.2	Principles of Oxy-acetylene gas welding.	1
2.3	A.C Metal-arc welding, Resistance welding, Submerged arc welding	2
2.4	Tungsten inert gas welding, Metal inert gas welding, plasma arc welding, Thermit welding	2
2.5	Electron beam welding, Laser beam welding, defects in welding,	2
2.6	Soldering and brazing.	1
3	FORMING AND SHAPING OF PLASTICS: Module 3 (9 hours)	
3.1	Blanking and piercing – Bending and forming – Rolling, Theory of Rolling, Types of Rolling Mills.	2
3.2	Drawing and its types – wire drawing and Tube drawing – coining – Hot and cold spinning – Types of presses and press tool	2
3.3	Basic extrusion processes and its characteristics	2
3.4	Forging processes - Principles of forging, tools and dies - Types of forging – Open, closed, drop forging, roll forging.	2
3.5	Moulding of Thermoplastics – Working principles and typical applications of - Injection moulding.	1
4	Non-Traditional Machining Processes : Module-4(9 hours)	
4.1	Non-Traditional Machining Processes: Need for non-traditional machining,	3
4.2	Principle, equipment & operation of Laser Beam, Plasma Arc Machining,	3
4.3	Electro Chemical Machining, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining, Electron Discharge Machining and Plasma Arc Machining	3
5	Advanced manufacturing techniques : Module-5(10 hours)	
5.1	Advanced manufacturing techniques –Material addition process: 3D Printing, stereo-lithography, selective laser sintering,	3
5.2	Fused deposition modelling, laminated object manufacturing, laser engineered net-shaping, LIGA process.	3
5.3	Sustainable and green manufacturing.application of nano technology	2
5.4	Manufacturing process capabilities – process selection factors process information maps – ranking strategy	2

MUT305	VEHICLE DYNAMICS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble:

This course aims at providing

1. Understand the dynamics of the automotive systems and its performance parameters.
2. Identify the driving/ braking resistances and their influences on vehicle dynamics.
3. To analyze dynamics systems such as suspension systems, body vibrations, steering mechanisms.
4. To Understand the vehicle aerodynamics and its effects on vehicle performance
5. To identify, formulate, and solve engineering problems related to vehicle dynamics

Prerequisite:

EST100 ENGINEERING MECHANICS
MUT206 MECHANICS OF SOLIDS
MUT203 AUTO CHASSIS

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

CO 1	To understand the vehicle system dynamics
CO 2	Evaluate the driving/ braking resistances and their influences on vehicle dynamics
CO 3	Identify and analyse the dynamics systems such as suspension systems, body vibrations, steering mechanisms.
CO 4	To analyse and solve engineering problems related to vehicle dynamics
CO 5	Comparing and identifying the different types of control systems in automobiles

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	1
CO 2	2	1	1	-	-	1	-	-	-	-	-	1
CO 3	2	2	1	-	1	-	-	-	-	-	-	1
CO 4	2	2	1	-	1	-	-	-	-	-	-	1
CO 5	2	1	1	-	2	-	-	-	-	1	-	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	10	10	20
Apply	20	20	50
Analyse	10	10	20
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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Are you able to classify / understand the vehicle system dynamics?

Course Outcome 2 (CO2)

1. Can you evaluate the driving/ braking resistances and their influences on vehicle dynamics?

Course Outcome 3(CO3):

1. Can you identify and analyse the dynamics systems such as suspension systems, body vibrations, steering mechanisms?

Course Outcome 4 (CO4):

1. Are you able to analyse and solve engineering problems related to vehicle dynamics?

Course Outcome 5 (CO5):

1. Can you able to compare classify / and identify the different types of control systems in automobiles?

MODEL QUESTION PAPER**QP CODE:****PAGES:...****Reg. No:** _____**Name :** _____**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY****FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR****Course Code: MUT 305****Course Name: VEHICLE DYNAMICS****Max. Marks: 100****Duration: 3 Hours****Part A****(Answer all questions. Each question carry 3 marks)**

1. Discuss briefly the fundamental approaches to solve the problem related to the vehicle dynamics
2. Explain the vehicle fixed coordinate system with a neat sketch.
3. Explain the term longitudinal dynamics and its significance in vehicle stability.
4. Obtain the expressions for stopping distance and braking efficiency.
5. Why do we require a suspension system? Explain the functions of a suspension system.
6. Explain the constructional details of gas and hydraulic dampers.
7. Derive the stability condition of a vehicle on a curved track and a banked road
8. Explain the terms i) self aligning torque, ii) power consumed by tire, iii) tire stiffness
9. What is the importance of vehicle aerodynamics? Explain the working principle of air dams.
10. Explain the working principle of ABS control module?

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

11. Discuss the steps in involved in modelling and simulation of dynamic behaviour of the vehicles. (14)

OR

12. (a) Explain SAE coordinate system with suitable sketches (7)
- (b) Discuss the history of road and off road vehicle system dynamics. (7)

13. An engine is required to power a truck having a gross weight of 40937 N. The maximum grade which the truck will have to negotiate at 32km/hr in 2nd gear is expected to be 20% (% grade = $\tan\theta \times 100$). The rolling resistance coefficient is 0.017

and the air resistance coefficient is 0.0324 in the relation, Total resistance = $K_f W + K_a AV^2$ N. The frontal area is 5.2 m². The transmission efficiency in 2nd gear is 80%. Calculate the minimum power which should be available from the engine and the gear ratio in 2nd gear if this power is available at 2400rpm and the effective radius of the wheels is 0.419 m. Also calculate the minimum speed of the vehicle in top gear on level road at the same engine speed assuming transmission efficiency of 90% in top gear. What is the gear ration in top gear? The differential has a reduction of 3.92. (14)

OR

14. Derive an expression for engine power required to propel a vehicle considering the losses in transmission also differentiate between Traction and Tractive effort? (14)

15. Determine the load carried by wheels at the outer and inner sides and the maximum value of coefficient of adhesion if there is no side slipping when the vehicle weighing 17795 N runs at 96 km/hr round a circular path so that the centre of gravity moves in a circle of radius 122m with its wheel axes at an angle of 12° to the horizontal. Its CG is 1.06 m above the ground level and wheel track is 1.3 m . (14)

OR

16. (a) Explain the What do you understand by hysteresis effect in tire and how it influences the rolling resistance. (7)

(b) What are the tire cornering characteristics? Analyze the main factors that affect them, and draw a curve to show the relationship between the self-aligning torque and the slip angle. (7)

17. (a) Explain the functions of a suspension system. Define roll axis. (7)

(b) Discuss the steps in design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model? (7)

OR

18. Obtain the final forces on the links of an independent suspension system under the action of the external forces. (14)

19. What are the effects of aerodynamic drag and lift coefficients on the vehicle characteristics? (14)

OR

20. Explain the salient features of various dynamic control systems used in automobiles. (14)

Syllabus: MUT 203 – VEHICLE DYNAMICS**3-1-0****Module 1: INTRODUCTION**

History of road and off road vehicle system dynamics - dynamics of the motor vehicle, coordinate systems- vehicle fixed coordinates system, , details of vehicle systems, wheel angles, typical data of vehicles. Fundamental approaches to vehicle dynamics modeling lumped mass, vehicle fixed coordinate system, motion variables, earth fixed coordinate system, SAE coordinate system, Euler angles ,forces, Newton's second law. Definitions- modeling and simulation of dynamic behaviour of vehicle., motion analysis, force analysis, and energy analysis.

Module 2: LONGITUDINAL DYNAMICS

Introduction to longitudinal dynamics - Performance of road vehicles: forces and moments on vehicle, equation of motion, tire forces, rolling resistance, weight distribution, tractive effort/tractive resistance and power available from the engine/ power required for propulsion, road performance curves- acceleration, grade ability, drawbar pull and the problems related to these terms.

Calculation of maximum acceleration braking torque, braking force, brake proportioning, braking efficiency, stopping distance, load distribution (three wheeled and four wheeled vehicles), calculation of acceleration, tractive effort and reactions for different drives, Stability of a vehicle on slope, (Problems related to these).

Module 3: LATERAL DYNAMICS

Introduction to lateral dynamics - Steering geometry, types of steering systems, fundamental condition for true rolling, development of lateral forces. slip angle, cornering force, cornering stiffness, pneumatic trail, self aligning torque, power consumed by tire, tire stiffness ,hysteresis effect in tires, steady state handling characteristics. yaw velocity, lateral acceleration, curvature response & directional stability.

Stability of a vehicle on a curved track and a banked road. gyroscopic effects, weight transfer during acceleration, cornering and braking, stability of a rigid vehicle and equations of motion of a rigid vehicle, cross wind handling, the problems related to these terms.

Module 4: VERTICAL DYNAMICS

Introduction to vertical dynamics - Human response to vibrations, classification of vibration, specification and vibration , sources of vibration, suspension systems, Modal Analysis, One DOF, two DOF, free and forced vibration, damped vibration, magnification and transmissibility, vibration absorber, functions of suspension system. body vibrations: bouncing and pitching. doubly conjugate points (only basic idea). body rolling. roll center and roll axis, roll axis and the vehicle under the action of side forces, stability against body rolling.

Vehicle dynamics and suspension design for stability, choice of suspension spring rate, chassis springs and theory of chassis springs, gas & hydraulic dampers and choice of damper, damper

characteristics, mechanics of an independent suspension system.. Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model.

Module 5: VEHICLE AERODYNAMIC AND DYNAMIC CONTROL SYSTEM

Road Loads: Air resistance-Mechanics of air flow around a vehicle, pressure distribution on a vehicle, factors affecting rolling resistance, aerodynamic forces – aerodynamic drag, drag components, drag coefficient, aerodynamic aids, aerodynamic side force, lift force, pitching moment, yawing moment, rolling moment, cross wind sensitivity .

Vehicle dynamic Control, modelling of actuators, sensors for automobile control, sensors for detecting vehicle environment, central tyre inflation system. Prediction of vehicle performance. ABS, stability control, traction control.

Text Books

1. Rajesh Rajamani, “Vehicle Dynamics and Control”, 1st edition, Springer, 2005
2. Singiresu S. Rao, “Mechanical Vibrations”, 5th Edition, Prentice Hall, 2010
3. Thomas D. Gillespie, “Fundamentals of Vehicle Dynamics”, Society of Automotive Engineers Inc, 1992
4. Wong. J. Y., “Theory of Ground Vehicles”, 3rd Edition, Wiley-Interscience, 2001
5. N.K. Giri, Automotive Mechanics, Kanna Publishers, 2007

Reference Books

1. Theory of Ground Vehicles - J. Y. Woung - John Willey & Sons, NY
2. Steering, Suspension & Tyres – J. G. Giles, Ilete Books Ltd., London
3. Mechanics of Road Vehicles – W. Steed, Ilete Books Ltd. London
4. Automotive Chassis – P. M. Heldt, Chilton Co. NK
5. Gillespie.T.D., “Fundamental of vehicle dynamic society of Automotive Engineers ",USA, 1992.
6. Vehicle dynamics and control by Rajesh Rajamani , Springer publication
7. Vehicle Dynamics : Theory and Application by Reza N Jazar, Springer publication.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction - Discussion on syllabus, Cos and POs	
1.1	History of road and off road vehicle system dynamics	1
1.2	dynamics of the motor vehicle, coordinate systems- vehicle fixed coordinates system, details of vehicle systems, wheel angles, typical data of vehicles.	2
1.3	Fundamental approaches to vehicle dynamics modeling lumped mass, vehicle fixed coordinate system	2

1.4	motion variables, earth fixed coordinate system, SAE coordinate system, Euler angle, forces, Newton's second law. Definitions	2
1.5	modeling and simulation of dynamic behaviour of vehicle motion analysis, force analysis, and energy analysis	2
2	Longitudinal dynamics	
2.1	Introduction to longitudinal dynamics - Performance of road vehicles: forces and moments on vehicle, equation of motion, tire forces,	2
2.2	rolling resistance, weight distribution, tractive effort/tractive resistance and power available from the engine/ power required for propulsion, grade ability, drawbar pull and the problems related to these terms. road performance curves	2
2.3	Calculation of maximum acceleration braking torque, braking force,	1
2.4	brake proportioning, braking efficiency, stopping distance, load distribution (three wheeled and four wheeled vehicles),	2
2.5	calculation of acceleration, tractive effort and reactions for different drives, Stability of a vehicle on slope, (Problems related to these).	2
3	Lateral Dynamics	
3.1	Introduction to lateral dynamics - Steering geometry, types of steering systems, fundamental condition for true rolling,	1
3.2	development of lateral forces. slip angle, cornering force, cornering stiffness, pneumatic trail, self aligning torque, power consumed by tire, tire stiffness	2
3.3	hysteresis effect in tires, steady state handling characteristics. yaw velocity, lateral acceleration, curvature response & directional stability.	2
3.4	Stability of a vehicle on a curved track and a banked road. gyroscopic effects, weight transfer during acceleration,	2
3.5	cornering and braking, stability of a rigid vehicle and equations of motion of a rigid vehicle, cross wind handling, the problems related to these terms.	2
4	Vertical Dynamics	
4.1	Introduction to vertical dynamics - Human response to vibrations, classification of vibration, specification and vibration ,	2
4.2	sources of vibration, suspension systems, Modal Analysis, One DOF, two DOF, free and forced vibration, damped vibration, magnification and transmissibility,	2
4.3	vibration absorber, functions of suspension system. body	2

	vibrations: bouncing and pitching. doubly conjugate points (only basic idea).	
4.4	body rolling. roll center and roll axis, roll axis and the vehicle under the action of side forces, stability against body rolling. Vehicle dynamics and suspension design for stability, choice of suspension spring rate,	1
4.5	chassis springs and theory of chassis springs, gas & hydraulic dampers and choice of damper, damper characteristics, mechanics of an independent suspension system..	1
4.6	Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model	1
5	Vehicle Aerodynamic and dynamic control system	
5.1	Road Loads: Air resistance-Mechanics of air flow around a vehicle, pressure distribution on a vehicle, factors affecting rolling resistance.	2
5.2	aerodynamic forces – aerodynamic drag, drag components, drag coefficient, aerodynamic aids, aerodynamic side force, lift force, pitching moment,	2
5.3	yawing moment, rolling moment, cross wind sensitivity . Vehicle dynamic Control	1
5.4	modelling of actuators, sensors for automobile control, sensors for detecting vehicle environment,	2
5.5	central tyre inflation system. Prediction of vehicle performance. ABS, stability control, traction control	2

Estd.



2014

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MUT307	AUTO TRANSMISSION	PCC	3	1	0	4

Preamble: This course aims at providing the students, an insight on the various transmission systems used in different types of automobiles.

Prerequisite: MU 203 Auto chassis theory of third semester.

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

CO 1	Understand and analyse the types of clutch and gearbox used in the automobiles
CO 2	Understand the basics of epicyclical gearbox and the propeller shaft
CO 3	Illustrate the working of epicyclical and hydrodynamic transmission system
CO 4	Understand the working of a hydrostatic transmission and Continuously Varying Transmission
CO 5	Understand the components and working of automatic transmissions used in the present-day vehicles

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	-	1	1	-	-	2	-	1
CO 2	2	1	-	2	-	1	2	-	-	2	-	1
CO 3	-	1	-	1	-	1	1	-	-	2	-	1
CO 4	-	-	-	-	-	1	1	-	-	2	-	1
CO 5	-	1	-	1	-	2	2	-	-	2	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. How automotive clutches are classified?
2. Explain the working of single plate automotive clutch
3. Give the advantages of diaphragm spring clutch over coil spring clutch.
4. What are the various clutch adjustments?
5. How a hydraulically operated clutch works?

Course Outcome 2 (CO2)

1. Distinguish between traction and tractive effort.
2. Explain the principle of operation of synchromesh gearbox.
3. How the gear ratios can be calculated?
4. What is the function of a transfer gearbox?
5. What are the different types of gears?

Course Outcome 3(CO3):

1. What are the basic laws of epicyclical gear drives?

2. List the different types of compound epicyclical gearbox.
3. Demonstrate the working of a fluid flywheel.
4. Explain the working of a torque converter
5. Give the advantages of hydrodynamic transmission

Course Outcome 4 (CO4):

1. Illustrate the working of a typical hydrostatic transmission.
2. What are the basic components of a hydrostatic transmission?
3. Explain the working of a belt type CVT
4. Illustrate the working of toroidal CVT
5. Give the advantages and disadvantages of CVT drives.

Course Outcome 5 (CO5):

1. What are the different types of automatic transmission?
2. List down the components in an automatic transmission
3. Explain the electronic control system used in automatic transmission
4. What are the sensors used in an automatic transmission system?
5. Explain the working of electric control system used in an electric vehicle

Model Question paper

QP CODE:
PAGES:02

Reg. No: _____

Name : _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MUT 307

Course Name: AUTO TRANSMISSION

Max. Marks: 100

Duration: 3 Hours

Part A

(Answer all questions. Each question carry 3 marks)

1. Explain the term Tractive effort
2. List the different types of friction clutches.
3. Why do we go for CV joints in front engine front wheel vehicles?

4. Explain the principle of an epicyclic gearbox
5. What is the principle of working of a hydrodynamic transmission?
6. Compare between fluid flywheel and torque converter
7. List down the advantages and disadvantages of a CVT
8. Draw the layout of a hydrostatic transmission system
9. Explain the functions of a TCM and PCM
10. List and explain the different modes of an automatic transmission

Part B

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

11. (a) Explain the working of single plate clutch with a neat diagram (7)
 (b) Discuss the working of centrifugal clutch with a sketch. (7)
- OR**
12. With a suitable sketch explain the working of a multi-plate diaphragm clutch (14)
13. Discuss the working of a five speed synchromesh gearbox (14)
- OR**
14. With a suitable sketch explain the working of a transfer gearbox (14)
15. Explain the working of a torque converter with a neat sketch (14)
- OR**
16. Explain the torque characteristics of a torque converter with graphs (14)
17. With a suitable sketch explain Janny Hydrostatic transmission with a cross sectional sketch (14)
- OR**
18. What are the different types of CVT? Explain the working of a typical Toroidal type CVT. (14)
19. Explain a typical control system employed for an automatic transmission (14)
- OR**
20. Give a brief discussion about the components and the working of an AMT system (14)

SYLLABUS

Module 1

Automotive Clutches: Requirements of clutch, principle of operation, constructional details different types of clutches- dry and wet type clutches, single plate and multi-plate coil spring clutches, diaphragm spring clutches, semi-centrifugal and centrifugal clutches, cone clutch, friction lining materials, clutch operating mechanisms – hydraulically operated clutches, factors influencing clutch wear & points of wear, clutch adjustments, clutch faults- diagnosis & remedies, torque capacity of a single plate clutch (derivation and problem).

Module 2

Automotive Gear box: Need for transmission system, forces acting on vehicle, tractive effort and traction, power-torque characteristics, performance characteristics at different speeds of gear box, construction and working principle of sliding mesh, constant mesh and synchromesh gear boxes. gear shifting mechanisms - gear shifting mechanism for sequential and extended ‘h’ shift-mechanical link and wire types, calculation of gear ratios of a vehicle, power and economy modes in gearbox, transfer gear box, transaxles, overdrives, types of gears, gear box maintenance, Gear box troubles and trouble shooting.

Module 3

Epicyclical Gearbox: Principle and fundamental laws of planetary / epicyclical gearing, construction and working of simple and compound epicyclical gearboxes- simpson, wilson, and revangnaux gearboxes.

Hydrodynamic transmission: Fluid coupling – principles, advantages, limitations, slip and performance characteristics, drag torque, reduction of drag torque. torque converter – principle, construction and working of three and four element torque converters, operational phases, performance characteristics, stall speed, lock up clutches. advantages, limitations, matching engine and torque converters.

Module 4

Hydrostatic drive: Principle of hydrostatic transmission system, Basic layout for hydrostatic vehicle transmission system, components of hydrostatic systems- types and classification based on spatial arrangement, transmission ratio and circuit construction- Pump and motor combinations for hydrostatic drives, advantages and limitations, construction and working of typical hydrostatic drives Janny Hydrostatic transmission, comparison of hydrostatic drive with hydrodynamic drive.

Continuously Varying Transmission: Components of CVT, Types of CVT- pulley-belt, toroidal and hydrostatic CVT, Application of CVT in automobile, advantages and disadvantages of CVT.

Module 5

Automatic Transmission: Components of automatic transmission- gear shift valve, vacuum and governor valve, sensors and actuators, PCM, TCM, Hydraulic and Electronically controlled systems of automatic transmission - AMT, DSG/ DCT transmission.

Text Books

1. Kirpal Singh, Automobile Engineering Volume 2, Standard Publishers and distributors,
2. Heldt.P.M., Torque converters, Chilton Book Co., 1962
3. Newton and Steeds, Motor vehicles, Illiffe Publishers, 1985.
4. N.K.Giri, Automotive Mechanics, Khanna Publishers. Edition: 8th, 2008

Reference Books

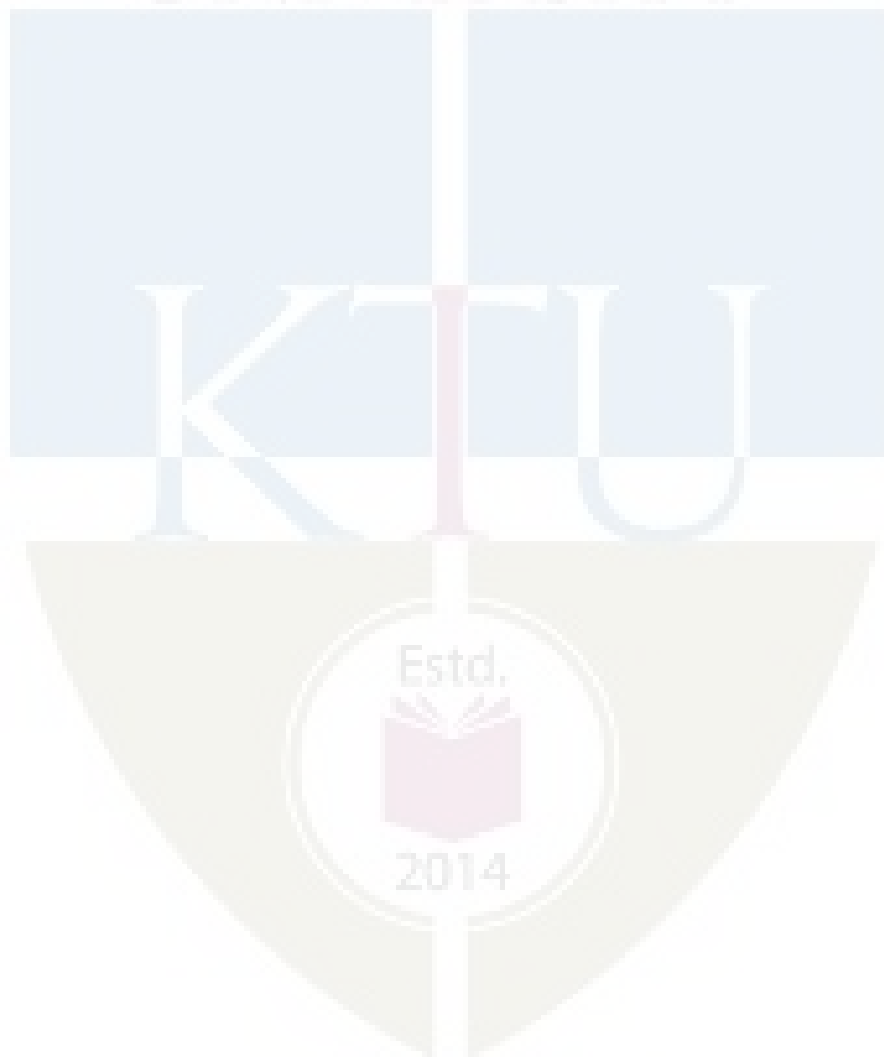
1. SAE Transactions 900550 & 930910
2. Hydrostatic transmissions for vehicle applications, I MechE Conference, 1981-88.
3. Crouse,W.H., Anglin,D.L., Automotive Transmission and Power Trains construction, McGraw Hill, 1976.
4. Heinz Heisler, Advance vehicle Technology, Butterworth-Heinemann

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	MODULE – 1: AUTOMOTIVE CLUTCHES	
1.1	Requirements of clutch, principle of operation, constructional details different types of clutches- dry and wet type clutches.	2
1.2	Single plate and multi-plate coil spring clutches.	1
1.3	Diaphragm spring clutches, clutch operating mechanisms – hydraulically operated clutches.	1
1.4	Semi-centrifugal and centrifugal clutches, cone clutch, friction lining materials.	1
1.5	factors influencing clutch wear & points of wear, clutch adjustments	1
1.6	clutch faults- diagnosis & remedies	1
1.7	Torque capacity of a single plate clutch (derivation and problem).	2
2	MODULE – 2: AUTOMOTIVE GEAR BOX	
2.1	Need for transmission system, forces acting on vehicle, tractive effort and traction	1
2.2	Power-torque characteristics, performance characteristics at different speeds of gear boxes	1
2.3	Construction and working principle of sliding mesh, constant mesh gear boxes.	1
2.4	Synchromesh gear boxes.	1

2.5	Gear shifting mechanisms - gear shifting mechanism for sequential and extended 'h' shift- mechanical link and wire types	1
2.6	Calculation of gear ratios of a vehicle, types of gears	1
2.7	Power and economy modes in gearbox,	1
2.8	Transfer gear box, transaxles, overdrives,	1
2.9	Gear box maintenance.	1
3	MODULE – 3: EPICYCLIC AND HYDRODYNAMIC TRANSMISSION	
3.1	Epicyclical Gearbox: Principle and fundamental laws of planetary / epicyclical gearing.	1
3.2	Construction and working of simple and compound Epicyclical gearboxes- Simpson gearboxes.	1
3.3	Construction and working of Wilson and Revangnaux gearboxes.	1
3.4	Hydrodynamic transmission: Fluid coupling – principles, advantages, limitations	1
3.5	Fluid coupling – slip and performance characteristics, drag torque, reduction of drag torque.	1
3.6	Torque converter – principle, construction and working of element torque converters.	1
3.7	Torque converter – principle, construction and working of four element torque converters, operational phases,	1
3.8	Torque converter – performance characteristics, stall speed, advantages, limitations.	1
3.9	Torque converter – lock up clutches, matching engine and torque converters.	1
4	MODULE – 4: HYDROSTATIC TRANSMISSION AND CVT	
4.1	Principle of hydrostatic transmission system, Basic layout for hydrostatic vehicle transmission system, components of hydrostatic systems, advantages and limitations	1
4.2	Hydrostatic transmission system types and classification based on spatial arrangement, transmission ratio and circuit construction.	1
4.3	Pump and motor combinations for hydrostatic drives	1
4.4	Hydrostatic transmission system- construction and working of typical hydrostatic drives Janny Hydrostatic transmission, comparison of hydrostatic drive with hydrodynamic drive.	1
4.5	Introduction to CVT- working	1
4.6	Types of CVT	1
4.7	Pulley - belt type CVT with different types of Belts employed	1
4.8	Toroidal and hydrostatic CVT	1
4.9	Application of CVT, advantages and disadvantages of CVT	1

5	MODULE – 5: AUTOMATIC TRANSMISSION	
5.1	Introduction to types of automatic transmission	1
5.2	Components of an automatic transmission	1
5.3	Working of AMT, DSG	1
5.4	Sensors used and Control system of an automatic transmission	2
5.5	Electric drives- Requirements and working	2
5.6	Ward Leonard electric drive	2



CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MUL331	PRODUCTION ENGINEERING LAB	PCC	0	0	3	2

Preamble: The lab provides basic application of the following:

- Types of machining to be selected for the manufacturing of components
- Parameters and optimisation of the machining parameters for better outputs
- Understand the different joining process employed in manufacturing
- Enumerate the basics of CNC machining and its methodology

Prerequisite: Nil

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

CO 1	Identify the machining operation involved for a component
CO 2	Illustrate the manufacturing sequence for developing a component
CO 3	Apply and optimise different criteria for machining of a component
CO 4	Develop and analyse a CNC programme using simulation software
CO 5	Enhance research capabilities by carrying out different research oriented experiments

Mapping of course outcomes with program outcomes

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

Course Level Assessment Questions

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: The following guidelines should be followed regarding award of marks

- | | |
|--|------------|
| (a) Preliminary work | : 15 Marks |
| (b) Implementing the work/Conducting the experiment | : 10 Marks |
| (c) Performance, result and inference (usage of equipments and trouble shooting) | : 25 Marks |
| (d) Viva voce | : 20 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.

Reference Books

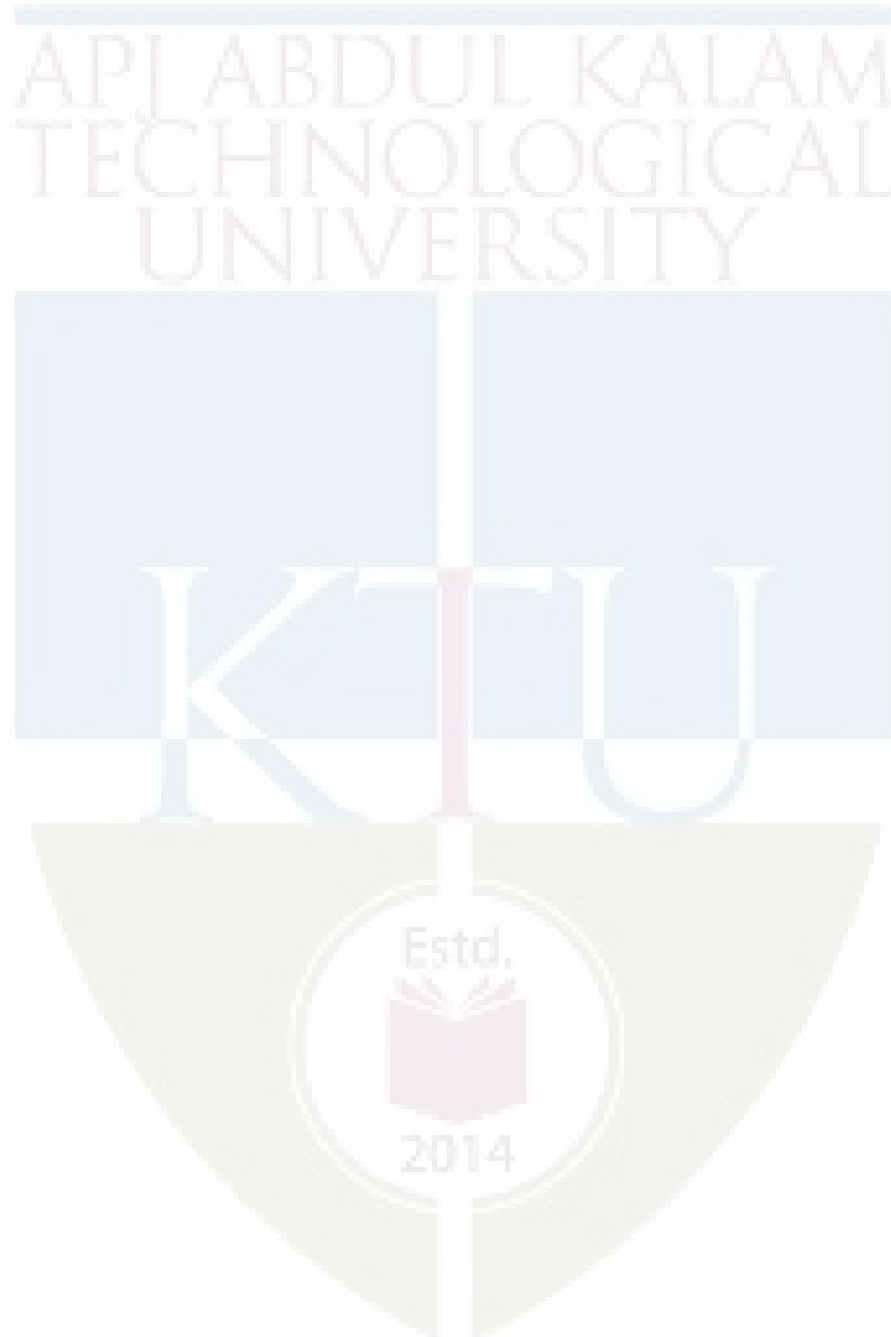
1. R. K. Jain, "Production Technology", Khanna Publishers, 18th Edition, 2013.
2. B. S. Raghuvamshi, "A Course in Workshop Technology", Dhanpat Rai & Sons, 2014.
3. Kalpakjian S, "Manufacturing Engineering and Technology", Pearson Education, 7th edition, 2014.
4. HMT, "Production Technology", McGraw-Hill Education, 1st Edition, 2008

List of Exercises/Experiments: (Lab experiments may be given considering 12 sessions of 3 hours each.)

1. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe machine.
2. Bolt (thread) making on Lathe machine
3. Tool grinding (to provide tool angles) on tool-grinder machine.
4. Gear cutting on Milling machine.
5. Machining a block on shaper machine.
6. Finishing of a surface on surface-grinding machine.
7. Drilling holes on drilling machine and study of twist-drill.
8. Study of different types of tools and its angles & materials.
9. Experiment on tool wear and tool life.
10. Experiment on jigs/Fixtures and its uses
11. Gas welding experiment
12. Arc welding experiment
13. Resistance welding experiment.
14. Soldering & Brazing experiment
15. CNC Programming Simulation using any software
16. CNC machining in CNC Lathe

17. CNC Milling in a VMC

18. Metal Cutting Experiments (Example: Cutting Force Measurement, Cutting Temperature Measurement etc.)



CODE	COURSE NAME:	CATEGORY	L	T	P	CREDIT
MEL333	THERMAL ENGINEERING LAB 1	PCC	0	0	3	2

Preamble: The course is intended to impart basic understanding on the working of internal combustion engines. This includes various performance tests on internal combustion engines as well as makes the students familiar with the evaluation of fuel properties such as viscosity, flash and fire points, calorific value etc. which are key to any performance test.

Prerequisite: Should have undergone a course on Thermal Engineering with emphasis on IC engines

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

CO 1	Measure thermo-physical properties of solid, liquid and gaseous fuels
CO 2	Identify various systems and subsystems of Diesel and petrol engines
CO 3	Analyse the performance characteristics of internal combustion engines
CO 4	Investigate the emission characteristics of exhaust gases from IC Engines
CO 5	Interpret the performance characteristics of air compressors / blowers

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		2	3			2		3	2		2
CO 2	3		2	3			2		3	2		2
CO 3	3		2	3			2		3	2		2
CO 4	3		2	3			2		3	2		2
CO 5	3		2	3			2		3	2		2

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: The following guidelines should be followed regarding award of marks

- | | |
|--|------------|
| (a) Preliminary work | : 15 Marks |
| (b) Implementing the work/Conducting the experiment | : 10 Marks |
| (c) Performance, result and inference (usage of equipments and trouble shooting) | : 25 Marks |
| (d) Viva voce | : 20 marks |
| (e) Record | : 5 Marks |

General instructions:

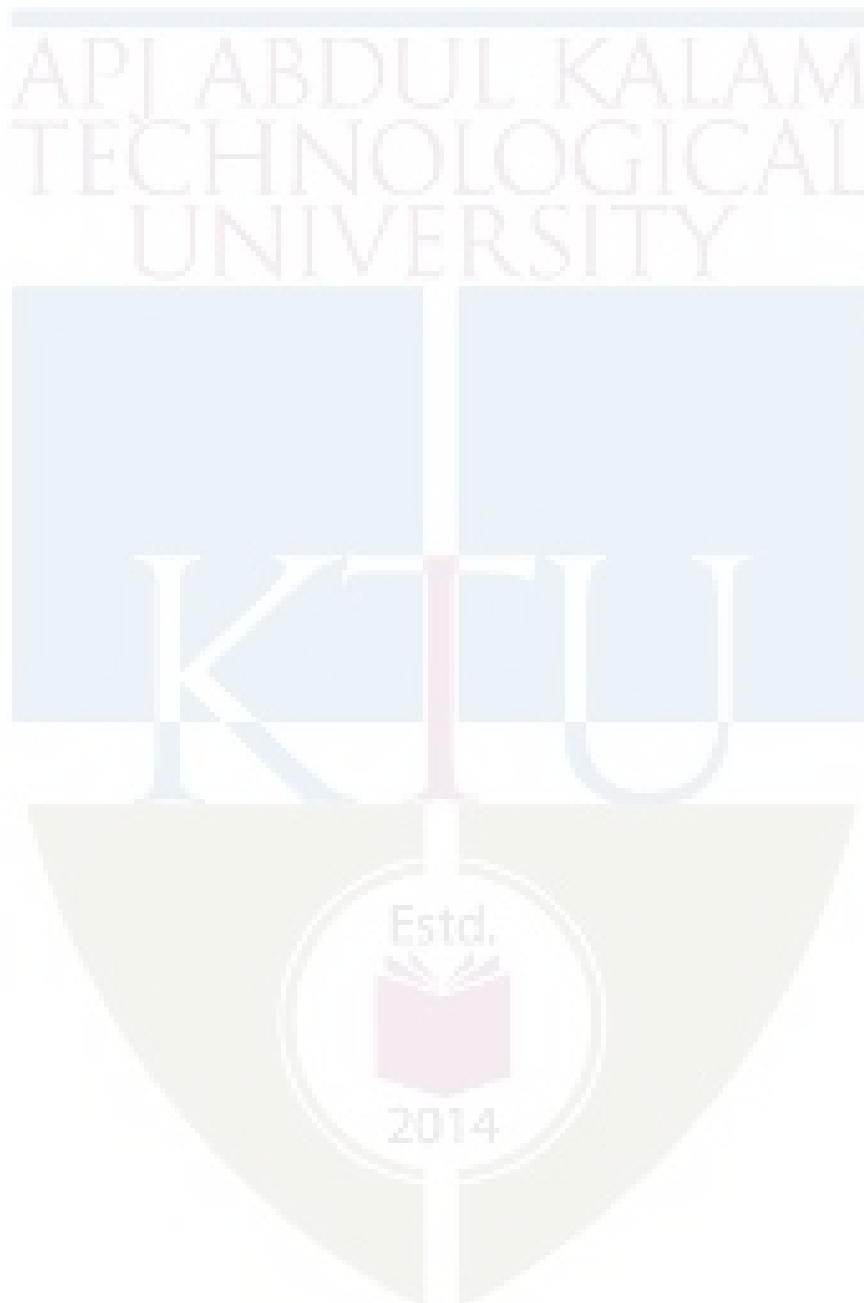
Practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should 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.

List of Exercises/Experiments: (Lab experiments may be given considering 12 sessions of 3 hours each. Minimum 12 experiments to be performed.)

1. Determination of flash and fire points of petroleum fuels and oils
2. Determination of viscosity of lubricating oils and fuels and its variation with temperature
3. Determination of calorific value of solid and liquid fuels- Bomb Calorimeter
4. Determination of calorific value of gaseous fuels –Gas Calorimeter
5. Familiarisation of various systems and subsystems of petrol engine / MPFI engine
6. Familiarisation of various systems and parts of Diesel engine / Turbocharged engine
7. Performance test on petrol engines / MPFI engine
8. Performance test on Diesel engines / Turbocharged engine
9. Heat Balance test on petrol/Diesel engines
10. Determination volumetric efficiency and Air-fuel ratio of IC engines
11. Cooling curve of IC engines
12. Valve timing diagram of IC engines
13. Economic speed test on IC engines
14. Retardation test on IC engines
15. Morse test on petrol engine
16. Experiment to find flame temperature of premixed flames at different equivalence ratios and temperature of diffusion flames at different fuel flow rates.
17. Analysis of automobile exhaust gas and flue gas using exhaust gas analyser.
18. Performance test on reciprocating compressor
19. Performance test on rotary compressor/blower

Reference Books

1. J.B.Heywood, I.C engine fundamentals, McGraw-Hill, 2017
2. V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill, 2017
3. Stephen R Turns, An Introduction to Combustion: Concepts and Applications, McGraw-Hill, 2017



APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

SEMESTER V

MINOR



AUT 381	DYNAMICS OF AUTOMOBILES	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims at providing

1. Understand the dynamics of the automotive systems and its performance parameters.
2. Identify the driving/ braking resistances and their influences on vehicle dynamics.
3. To analyze dynamics systems such as suspension systems, body vibrations, steering mechanisms.
4. To Understand the vehicle aerodynamics and its effects on vehicle performance
5. To identify, formulate, and solve engineering problems related to vehicle dynamics.

Prerequisite: ENGINEERING MECHANICS
AUTO CHASSIS AND ENGINE COMPONENTS

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

CO 1	To understand the vehicle system dynamics
CO 2	Evaluate the driving/ braking resistances and their influences on vehicle dynamics
CO 3	Identify and analyse the dynamics systems such as suspension systems, body vibrations, steering mechanisms.
CO 4	To analyse and solve engineering problems related to vehicle dynamics
CO 5	Comparing and identifying the different types of control systems in automobiles

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	2	1	1	-	-	1	-	-	-	-	-	2
CO 3	2	2	1	-	1	-	-	-	-	-	-	2
CO 4	2	2	1	-	1	-	-	-	-	-	-	2
CO 5	2	2	1	-	2	-	-	-	-	1	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	10	10	20
Apply	20	20	50
Analyse	10	10	20
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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Are you able to classify/understand the vehicle system dynamics?

Course Outcome 2 (CO2)

1. Can you evaluate the driving/ braking resistances and their influences on vehicle dynamics?

Course Outcome 3(CO3):

1. Can you identify and analyse the dynamics systems such as suspension systems, body vibrations, steering mechanisms?

Course Outcome 4 (CO4):

1. Are you able to analyse and solve engineering problems related to vehicle dynamics?

Course Outcome 5 (CO5):

1. Can you able to compare classify / and identify the different types of control systems in automobiles?

MODEL QUESTION PAPER**QP CODE:****PAGES:...****Reg. No:** _____**Name :** _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AUT281**Course Name: DYNAMICS OF AUTOMOBILES****Max. Marks: 100****Duration: 3 Hours****Part A****(Answer all questions. Each question carry 3 marks)**

1. Discuss briefly the fundamental approaches to solve the problem related to the vehicle dynamics
2. Explain the vehicle fixed coordinate system with a neat sketch.
3. Explain the term longitudinal dynamics and its significance in vehicle stability.
4. Obtain the expressions for stopping distance and braking efficiency.
5. Why do we require a suspension system? Explain the functions of a suspension system.
6. Explain the constructional details of gas and hydraulic dampers.
7. Derive the stability condition of a vehicle on a curved track and a banked road
8. Explain the terms i) self aligning torque, ii) power consumed by tire, iii) tire stiffness
9. What is the importance of vehicle aerodynamics? Explain the working principle of air dams.
10. Explain the working principle of ABS control module?

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

11. Discuss the steps involved in modelling and simulation of dynamic behaviour of the vehicles. (14)

OR

12. (a) Explain SAE coordinate system with suitable sketches (7)
 (b) Discuss the history of road and off road vehicle system dynamics. (7)

13. An engine is required to power a truck having a gross weight of 40937 N. The maximum grade which the truck will have to negotiate at 32km/hr in 2nd gear is expected to be 20% (% grade = $\tan\theta \times 100$). The rolling resistance coefficient is 0.017 and the air resistance coefficient is 0.0324 in the relation, Total resistance = $K_f W + K_a A V^2$ N. The frontal area is 5.2 m². The transmission efficiency in 2nd gear is 80%. Calculate the minimum power which should be available from the engine and the gear ratio in 2nd gear if this power is available at 2400rpm and the

effective radius of the wheels is 0.419 m. Also calculate the minimum speed of the vehicle in top gear on level road at the same engine speed assuming transmission efficiency of 90% in top gear. What is the gear ration in top gear? The differential has a reduction of 3.92.

(14)

OR

14. Derive an expression for engine power required to propel a vehicle considering the losses in transmission also differentiate between Traction and Tractive effort?

(14)

15. Determine the load carried by wheels at the outer and inner sides and the maximum value of coefficient of adhesion if there is no side slipping when the vehicle weighing 17795 N runs at 96 km/hr round a circular path so that the centre of gravity moves in a circle of radius 122m with its wheel axes at an angle of 12° to the horizontal. Its CG is 1.06 m above the ground level and wheel track is 1.3 m .

(14)

OR

16. (a) What do you understand by hysteresis effect in tire and how it influences the rolling resistance. (7)

(b) What are the tire cornering characteristics? Analyze the main factors that affect them, and draw a curve to show the relationship between the self-aligning torque and the slip angle. (7)

17. (a) Explain the functions of a suspension system. Define roll axis. (7)

(b) Discuss the steps in design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model? (7)

OR

18. Obtain the final forces on the links of an independent suspension system under the action of the external forces. (14)

19. What are the effects of aerodynamic drag and lift coefficients on the vehicle characteristics?

OR

20. Explain the salient features of various dynamic control systems used in automobiles. (14)

Syllabus: AUT 381–DYNAMICS OF AUTOMOBILES 3-1-0**Module 1: INTRODUCTION**

History of road and off road vehicle system dynamics - dynamics of the motor vehicle, coordinate systems- vehicle fixed coordinates system, , details of vehicle systems, wheel angles, typical data of vehicles. Fundamental approaches to vehicle dynamics modeling lumped mass, vehicle fixed coordinate system, motion variables, earth fixed coordinate system, SAE coordinate system, Euler angles, forces, Newton's second law. Definitions-modeling and simulation of dynamic behaviour of vehicle., motion analysis, force analysis, and energy analysis.

Module 2: LONGITUDINAL DYNAMICS

Introduction to longitudinal dynamics - Performance of road vehicles: forces and moments on vehicle, equation of motion, tire forces, rolling resistance, weight distribution, tractive effort/tractive resistance and power available from the engine/ power required for propulsion, road performance curves- acceleration, grade ability, drawbar pull and the problems related to these terms. Calculation of maximum acceleration braking torque, braking force, brake proportioning, braking efficiency, stopping distance, load distribution (three wheeled and four wheeled vehicles), calculation of acceleration, tractive effort and reactions for different drives, Stability of a vehicle on slope, (Problems related to these).

Module 3: TIRE MECHANICS AND LATERAL DYNAMICS

Introduction to lateral dynamics - Steering geometry, types of steering systems, fundamental condition for true rolling, development of lateral forces. slip angle, cornering force, cornering stiffness, pneumatic trail, self aligning torque, power consumed by tire, tire stiffness ,hysteresis effect in tires, steady state handling characteristics. yaw velocity, lateral acceleration, curvature response & directional stability. Elastic Band Model for longitudinal slip, Simple model for lateral slip, Combined longitudinal/lateral slip (friction ellipse), Taut string model for lateral slip, Magic Tire Formula. Stability of a vehicle on a curved track and a banked road. gyroscopic effects, weight transfer during acceleration, cornering and braking, stability of a rigid vehicle and equations of motion of a rigid vehicle, cross wind handling, the problems related to these terms.

Module 4: VERTICAL DYNAMICS

Introduction to vertical dynamics - Human response to vibrations, classification of vibration, specification and vibration , sources of vibration, suspension systems, Modal Analysis, One DOF, two DOF, free and forced vibration, damped vibration, magnification and transmissibility, vibration absorber, functions of suspension system. body vibrations: bouncing and pitching. doubly conjugate points (only basic idea). body rolling. roll center and roll axis, roll axis and the vehicle under the action of side forces, stability against body rolling.

Vehicle dynamics and suspension design for stability, choice of suspension spring rate, chassis

springs and theory of chassis springs, gas & hydraulic dampers and choice of damper, damper characteristics, mechanics of an independent suspension system.. Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model.

Module 5: DYNAMIC CONTROL SYSTEM AND AERODYNAMICS

Vehicle dynamic Control, modelling of actuators, sensors for automobile control, sensors for detecting vehicle environment, central tyre inflation system. Prediction of vehicle performance. ABS, stability control, traction control. Roll over mitigation system, *Traction control system*, hill descent control system, Emergency braking, Structure of Vehicle Dynamics Control System (case study)

Road Loads: Air resistance-Mechanics of air flow around a vehicle, pressure distribution on a vehicle, factors affecting rolling resistance, aerodynamic forces – aerodynamic drag, drag components, drag coefficient, aerodynamic aids, aerodynamic side force, lift force, pitching moment, yawing moment, rolling moment, cross wind sensitivity.

Text Books

1. Rajesh Rajamani, “Vehicle Dynamics and Control”, 1st edition, Springer, 2005
2. Singiresu S. Rao, “Mechanical Vibrations”, 5th Edition, Prentice Hall, 2010
3. Thomas D. Gillespie, “Fundamentals of Vehicle Dynamics”, Society of Automotive Engineers Inc, 1992
4. Wong. J. Y., “Theory of Ground Vehicles”, 3rd Edition, Wiley-Interscience, 2001
5. N.K. Giri, Automotive Mechanics, Kanna Publishers, 2007

Reference Books

1. Theory of Ground Vehicles - J. Y. Woung - John Willey & Sons, NY
2. Steering, Suspension & Tyres – J. G. Giles, Ilete Books Ltd., London
3. Mechanics of Road Vehicles – W. Steed, Ilete Books Ltd. London
4. Automotive Chassis – P. M. Heldt, Chilton Co. NK
5. Gillespie.T.D., “Fundamental of vehicle dynamic society of Automotive Engineers”, USA, 1992.
6. Vehicle dynamics and control by Rajesh Rajamani , Springer publication
7. Vehicle Dynamics : Theory and Application by Reza N Jazar, Springer publication.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction - Discussion on syllabus, Cos and POs	
1.1	History of road and off road vehicle system dynamics	1
1.2	dynamics of the motor vehicle, coordinate systems- vehicle fixed coordinates system, details of vehicle systems, wheel angles, typical data of vehicles.	2

1.3	Fundamental approaches to vehicle dynamics modeling lumped mass, vehicle fixed coordinate system	2
1.4	motion variables, earth fixed coordinate system, SAE coordinate system, Euler angle, forces, Newton's second law. Definitions	2
1.5	modeling and simulation of dynamic behaviour of vehicle motion analysis, force analysis, and energy analysis	2
2	Longitudinal dynamics	
2.1	Introduction to longitudinal dynamics - Performance of road vehicles: forces and moments on vehicle, equation of motion, tire forces,	2
2.2	rolling resistance, weight distribution, tractive effort/tractive resistance and power available from the engine/ power required for propulsion, grade ability, drawbar pull and the problems related to these terms. road performance curves	2
2.3	Calculation of maximum acceleration braking torque, braking force,	1
2.4	brake proportioning, braking efficiency, stopping distance, load distribution (three wheeled and four wheeled vehicles),	2
2..5	calculation of acceleration, tractive effort and reactions for different drives, Stability of a vehicle on slope, (Problems related to these).	2
3	Lateral Dynamics	
3.1	Introduction to lateral dynamics - Steering geometry, types of steering systems, fundamental condition for true rolling,	1
3.2	development of lateral forces. slip angle, cornering force, cornering stiffness, pneumatic trail, self aligning torque, power consumed by tire, tire stiffness	2
3.3	hysteresis effect in tires, steady state handling characteristics. yaw velocity, lateral acceleration, curvature response & directional stability.	2
3.4	Stability of a vehicle on a curved track and a banked road. gyroscopic effects, weight transfer during acceleration,	2
3.5	cornering and braking, stability of a rigid vehicle and equations of motion of a rigid vehicle, cross wind handling, the problems related to these terms. .Elastic Band Model for longitudinal slip, Simple model for lateral slip, Combined longitudinal/lateral slip (friction ellipse), Taut string model for lateral slip, Magic Tire Formula.	2
4	Vertical Dynamics	
4.1	Introduction to vertical dynamics - Human response to vibrations,	2

	classification of vibration, specification and vibration ,	
4.2	sources of vibration, suspension systems, Modal Analysis, One DOF, two DOF, free and forced vibration, damped vibration, magnification and transmissibility,	2
4.3	vibration absorber, functions of suspension system. body vibrations: bouncing and pitching. doubly conjugate points (only basic idea).	2
4.4	body rolling. roll center and roll axis, roll axis and the vehicle under the action of side forces, stability against body rolling. Vehicle dynamics and suspension design for stability, choice of suspension spring rate,	1
4.5	chassis springs and theory of chassis springs, gas & hydraulic dampers and choice of damper, damper characteristics, mechanics of an independent suspension system..	1
4.6	Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model	1
5	Vehicle Aerodynamic and dynamic control system	
5.1	Road Loads: Air resistance-Mechanics of air flow around a vehicle, pressure distribution on a vehicle, factors affecting rolling resistance.	2
5.2	aerodynamic forces – aerodynamic drag, drag components, drag coefficient, aerodynamic aids, aerodynamic side force, lift force, pitching moment,	2
5.3	Yawing moment, rolling moment, cross wind sensitivity . Vehicle dynamic Control	1
5.4	modelling of actuators, sensors for automobile control, sensors for detecting vehicle environment,	2
5.5	central tyre inflation system. Prediction of vehicle performance. ABS, stability control, traction control, stability control, traction control. Roll over mitigation system, <i>Traction control system</i> , hill descent control system, Emergency braking, Structure of Vehicle Dynamics Control System (case study)	2

APJ ABDUL KALAM
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SEMESTER V

HONOURS

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CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MUT393	ADVANCED THEORY OF VIBRATIONS	VAC	3	1	0	4

Preamble: This course aims at providing the student

- the theories pertaining to vibrations along with the method of evaluation and controlling of vibrations
- Understand and characterize the single and multi-degrees of freedom systems subjected to free and forced vibrations with and without damping.
- Understand the method of vibration measurements and its controlling.
- Understand the concept of dynamic vibrations of a continuous system.

Prerequisite: Mechanics of Solids

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

CO 1	Identify and evaluate systems with single degrees of freedom.
CO 2	Elaborate on systems with two degrees of freedom
CO 3	Analyse and solve vibration with multiple degrees of freedom
CO 4	Identify the methods for the measurement of vibration and apply the methods to solve it
CO 5	Enumerate on transient and non linear vibrations in a system.

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	-	-	2	-	-	-	-	-	-	-	1
CO 2	1	-	3	2	-	-	-	-	-	-	-	2
CO 3	1	-	3	2	-	2	-	-	-	-	-	2
CO 4	1	-	3	2	-	-	-	-	-	-	-	2
CO 5	1	-	3	2	-	2	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
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 maximum 3 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Explain one DOF system
2. Understand the basis of energy dissipation
3. Apply the basic equation of vibration for a single DOF system

Course Outcome 2 (CO2)

1. Understand the system of a two DOF system
2. Identify the modes of vibrations in a geared system

Course Outcome 3(CO3):

1. Identify the different numerical methods of evaluation of the output response of a vibratory system

Course Outcome 4 (CO4):

1. Explain the effect of whirling of shafts

- Identify the effect related to natural frequency and method to identify the natural frequency of a system

Course Outcome 5 (CO5):

- Illustrate on transient vibration of a system
- Understand the non linear vibrations and approximations and methodologies to evaluate it.

Model Question paper

QP CODE: _____

PAGES:...

Reg. No: _____

Name : _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MUT 393

Course Name: ADVANCED THEORY OF VIBRATIONS

Max. Marks: 100

Duration: 3 Hours

Part A

(Answer all questions. Each question carry 3 marks)

- List the different parts of a vibrating system with a neat diagram
- Derive the equation for the amplitude of a rotating unbalanced mass with forced vibration and damping.
- Explain forced vibration of a two DoF system. Write down its equation in matrix form
- Derive the equation in matrix form for a forced harmonic vibration 2 DoF system
- Explain Dunkerley's method for the evaluation of natural frequency
- List down the steps employed in the Stodola method for finding the natural frequency of a system
- Explain the term critical speed
- How damping can affect the critical speed?
- List some of the examples for transient vibrations
- List down the differences between linear and non linear vibrations

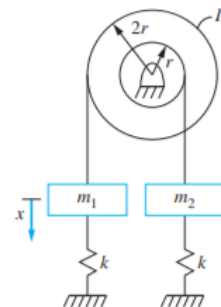
Part B

Answer any one full question from each module.

Each question carries 14 Marks

- Derive the differential equation governing the motion of the simple pendulum using ' θ ' as the counter-clockwise angular displacement of the pendulum from the system's horizontal equilibrium position and as the generalized coordinate. (14)

OR



12. Consider the system shown in the Figure. Let x describe the downward displacement of m_1 from the system's equilibrium position.

(a) Derive the differential equation governing $x(t)$.

(b) Determine the reaction at the center of the disk at the pin support in terms of x, \dot{x}, \ddot{x} (14)

13. In a vibratory system, the motions are expressed by the following equations.

$$x + 80\ddot{x} + 90\theta = 0; \quad \ddot{\theta} + 800\theta + 90x = 0$$

If the system is turned through 1.5 radians and released, find the frequencies and mode shapes (14)

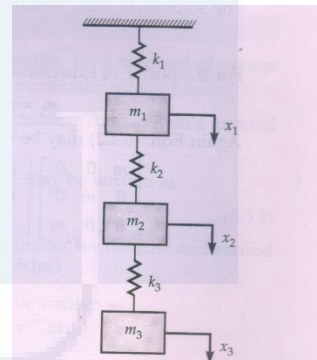
OR

14. A machine runs at 5000rpm. Its forcing frequency is very near to its natural frequency. If the nearest frequency of the machine is to set atleast 20% from the forced frequency, design a suitable vibration absorber for the system. Assume the mass of the machine as 30kg (14)

15. Using matrix method, solve the equation of motion of the system shown in the figure below

16.

OR



Illustrative Example 7.2.1

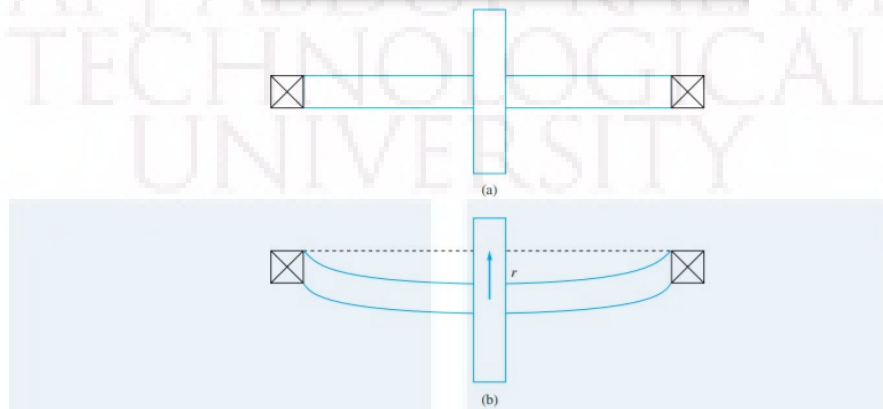
Find the lower natural frequency of vibration for the system shown in Fig. 7.2.1 by Rayleigh's method.

$E = 1.96 \times 10^{11} \text{ N/m}^2$

$I = 4.0 \times 10^{-7} \text{ m}^4$

Fig. 7.2.1 Fundamental frequency determination by Rayleigh's method

17. The rotor of figure consists of a disk mounted on a shaft. Unfortunately, the disk is unbalanced, and the center of mass is a distance e from the center of the shaft. As the disk rotates, this causes a phenomena called “whirl”, where the disk bows. Let r be the instantaneous distance from the center of the shaft to the original axis of the shaft and θ be the angle made by a given radius with the horizontal. Determine the acceleration of the mass center of the disk. (14)



OR

18. An electric motor is suspended on a spring and a dashpot. The spring has a stiffness of 6400N/m and the dashpot offers a resistance of 500N at 4m/s . The unbalanced mass 0.5kg rotates at 5cm radius and the total mass of the vibratory system is 20kg . The motor runs at 400rpm . Determine (a) Damping factor; (b) amplitude of vibration and the phase angle (c) Resonant speed and resonant amplitude (14)
19. A force $F(t)$ is suddenly applied to a mass m which is supported by a spring with a constant stiffness k . After a short period of time T , the force is suddenly removed. During the time the force is active, it is kept constant, F . Determine the response of the system if $t > T$. The spring and the mass are initially in rest before the force $F(t)$ is applied (14)

OR

20. Explain any one methodology adopted for the estimation of non linear vibrations (14)

Syllabus

Module 1: Forced vibrations (1DOF)

Introduction, analysis of forced vibration with constant harmonic excitation, MF, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility, energy dissipated due to damping and numerical problems.

Module 2: Systems with 2DOF

Principal modes of vibrations, normal mode and natural frequencies of systems (Damping is not included), simple spring mass systems, masses on tightly stretched strings, double pendulum, tensional systems, combined rectilinear and angular systems, geared systems and numerical problems.

Module 3: Numerical methods for multi DOF systems

Maxwell's reciprocal theorem, influence coefficients, Rayleigh's method, Dunkerley's method, Stodola method, orthogonality principle, method of matrix iteration and numerical problems.

Module 4: Vibration measuring instruments and whirling of shafts.

seismic instruments, vibrometers, accelerometer, frequency measuring instruments and numerical. Whirling of shafts with and without damping.

Vibration Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers and Vibration dampers.

Module 5:

Transient Vibration of single Degree-of freedom systems: Impulse excitation, arbitrary excitation, Laplace transforms formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation.

Non linear Vibrations: Difference between linear and non linear vibrations, Application of super position principle, estimation and determination of non linear vibrations.

Text Books

1. S. S. Rao, "Mechanical Vibrations", Pearson Education.
2. S. Graham Kelly, "Fundamentals of Mechanical Vibration" - McGraw-Hill.
3. William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan , "Theory of Vibration with Application" , 5th edition, Pearson Education.
4. "Mechanical Vibrations", V. P. Singh, Dhanpat Rai & Company.
5. Mechanical Vibrations, W.T. Thomson- Prentice Hill India

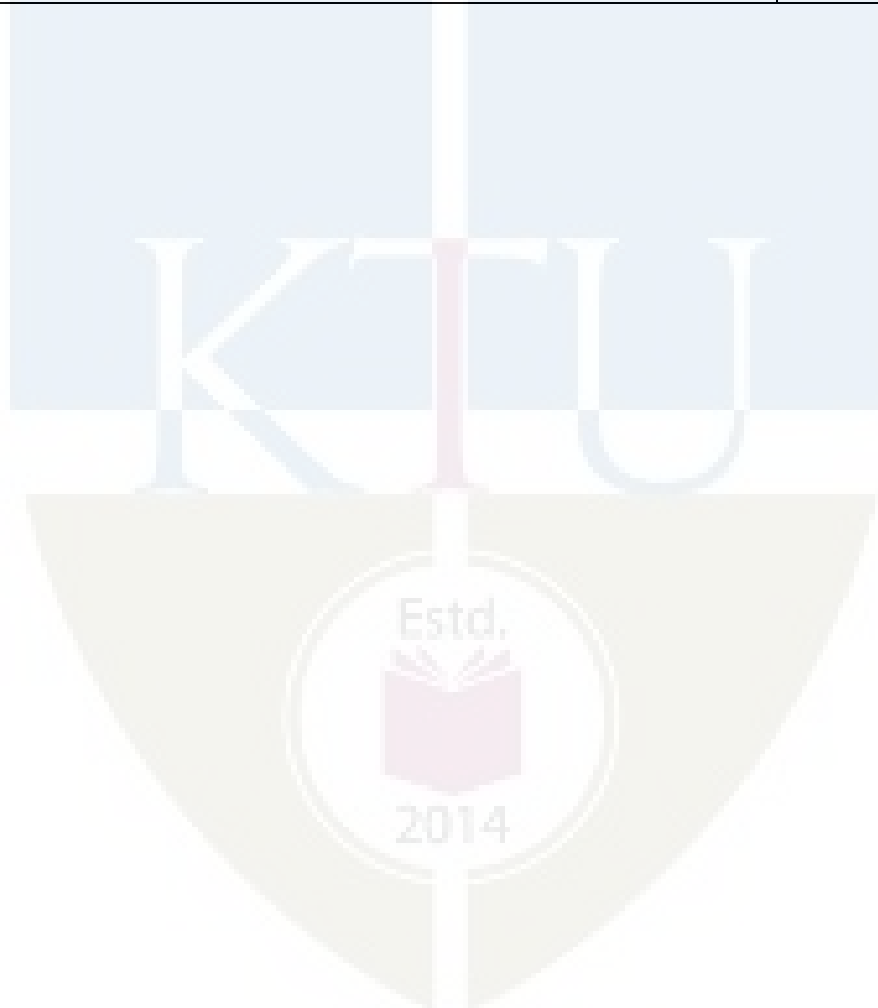
Reference Books

1. S. Graham Kelly, “Mechanical Vibrations”, Schaum’s Outlines, Tata McGraw Hill.
2. C Sujatha, “Vibrations and Acoustics – Measurements and signal analysis”, Tata McGraw Hill.
3. “Mechanical Vibrations”, G. K. Grover, Nem Chand and Bros

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Forced vibrations (1DOF)	
1.1	Introduction	1
1.2	Analysis of forced vibration with constant harmonic excitation	1
1.3	MF, rotating and reciprocating unbalances	2
1.4	Excitation of support (relative and absolute amplitudes)	2
1.5	Force and motion transmissibility	2
1.6	Energy dissipated due to damping and numerical problems	2
2	Systems with 2DOF	
2.1	Principal modes of vibrations	1
2.2	Normal mode and natural frequencies of systems	1
2.3	Simple spring mass systems	1
2.4	Masses on tightly stretched strings, double pendulum	1
2.5	Tensional systems, combined rectilinear and angular systems	2
2.6	Geared systems.	1
2.7	Numerical problems	3
3	Numerical methods for multi DOF systems	
3.1	Maxwell’s reciprocal theorem, influence coefficients,	1
3.2	Rayleigh’s method	1
3.3	Dunkerley’s method	2
3.4	stodola method	2
3.5	orthogonality principle	2
3.6	method of matrix iteration	1
3.7	numerical problems.	1
4	Vibration measuring instruments and whirling of shafts	
4.1	Seismic instruments, vibrometers, accelerometer	1
4.2	Frequency measuring instruments	1
4.3	Numerical problems	1
4.4	Whirling of shafts with and without damping	2
4.5	Introduction to Vibration Control	1
4.6	Vibration isolation theory	1

4.7	Vibration isolation and motion isolation for harmonic excitation	1
4.8	Practical aspects of vibration analysis, vibration isolation	1
4.9	Dynamic vibration absorbers and Vibration dampers	1
5	Transient Vibration of single Degree-of freedom systems and Non linear Vibrations:, ,	
5.1	Impulse excitation, arbitrary excitation	1
5.2	Laplace transforms formulation	2
5.3	Pulse excitation and rise time, Shock response spectrum, Shock isolation	1
5.4	Difference between linear and non linear vibrations	1
5.5	Application of super position principle	2
5.6	Estimation and determination of non linear vibrations.	3



APJ ABDUL KALAM
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SEMESTER VI

KTU



Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	25	25	50
Understand	25	25	50
Apply			
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 anyone. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Explain the inversion of a for bar chain.
2. Compare Davis and Ackerman's steering gear mechanisms.
3. Classify Kinematic pairs with examples.
4. Differentiate between self-locking and self-energising brakes.
5. What is a clutch? State its different types.

Course Outcome 2(CO2):

1. Explain the classification of cam followers.

2. Derive the expression for maximum velocity and acceleration for a follower moving with simple harmonic motion.

Course Outcome 3 (CO3):

1. Explain interference in involute gears. Explain any method to avoid interference.
2. Derive equation for path of contact and arc of contact of mating gears.
3. List various types of gear trains and their applications.

Course Outcome 4 (CO4):

1. Define coefficient of fluctuation of energy and coefficient fluctuation of speed
2. What is the main function of a flywheel?
3. Draw the turning moment diagram for a 4-stroke engine
4. Write a short note on primary and secondary balancing.
5. Explain hammer blow and swaying couple.
6. Derive the magnitude of unbalanced primary and secondary forces in a V-engine.

Course Outcome 5 (CO5):

1. What are the basic elements of a vibrational system? What is meant by degrees of freedom of a vibrational system?
2. What is logarithmic decrement? Derive the expression for the same.
3. What is meant by magnification factor in case of forced vibrations? On what factors does it depend?

Estd.



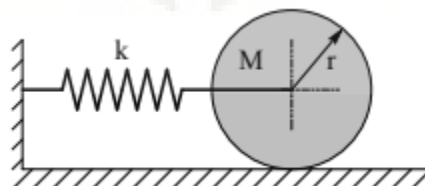
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Model Question paper**QP CODE:****PAGES: 4****Reg. No:** _____**Name :** _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: AUT302**Course Name: MECHANICS OF MACHINERY****Max. Marks: 100****Duration: 3 Hours****PART A****Answer all Questions.****Each question carries 3 Marks (2 questions from each module)**

- 1) What is meant by inversion? Name the inversions of a slider crank chain.
- 2) Define the following terms.
 - a) Mechanism
 - b) Kinematic Pair
 - c) Kinematic Chain
 - d) Kinematic link
 - e) Machine.
- 3) Explain the working of a centrifugal clutch.
- 4) Derive the expression for maximum velocity and acceleration of a follower moving with cycloidal motion.
- 5) State and prove law of gearing.
- 6) Explain different types of gear trains.
- 7) Draw the turning moment diagram for a four-stroke engine.
- 8) Differentiate static balancing and dynamic balancing.
- 9) Find the frequency of oscillations of the system shown in figure.



10) What is meant by logarithmic decrement? Derive the expression for the same.

PART B

Answer any one full question from each module.

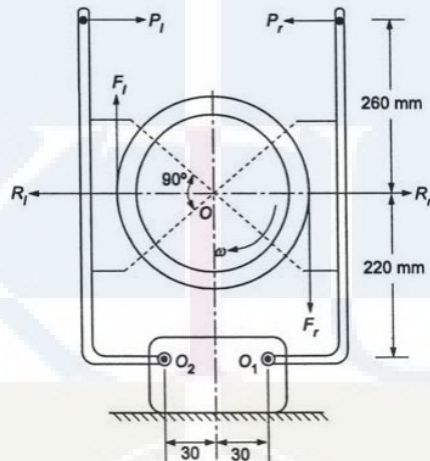
Each question carries 14 Marks

Module 1

11) With the help of neat sketches explain the classifications of kinematic pairs.

Or

12) A double-shoe (shown in figure) brake can absorb a torque of 1500 Nm. The diameter of the brake drum is 300 mm and the angle of contact for each shoe is 90° . The coefficient of friction between the brake drum and the lining is 0.35. Find (a) the spring force necessary to set the brake and (b) width of the brake shoes. The bearing pressure on the lining material is not to exceed 0.25MPa.



Module 2

13) A single-plate clutch, with both sides effective, has inner and outer diameters of friction surface 250 mm and 350 mm, respectively. The maximum intensity of pressure is not to exceed 0.15 MPa. The coefficient of friction is 0.3. Determine the power transmitted by the clutch at a speed of 2400 rpm for

- Uniform Wear
- Uniform Pressure.

Or

14) Design a cam to raise a valve with simple harmonic motion through 50 mm in $1/3$ of a revolution, keep it fully raised through $1/12$ revolution and to lower it with harmonic motion in $1/6$ revolution. The valve remains closed during the rest of the revolution. The diameter of the roller is 20 mm and the minimum radius of the cam is 25 mm. The diameter of the

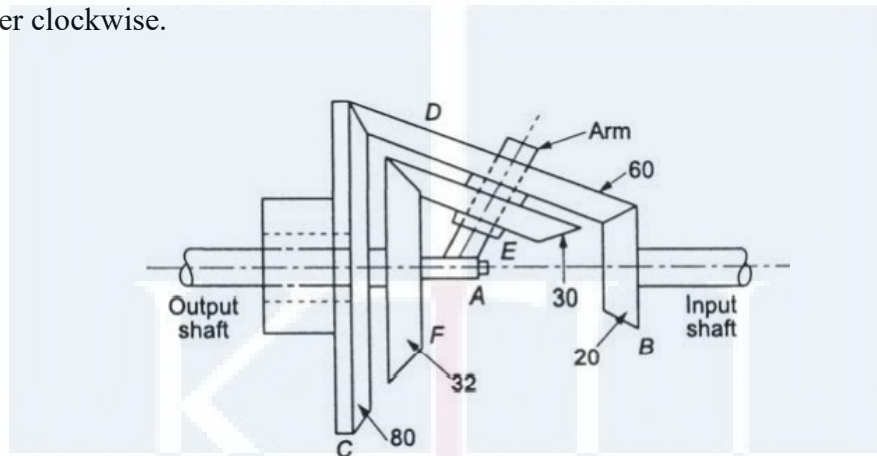
camshaft is 25 mm. The axis of the valve rod passes through the axis of the camshaft. If the camshaft rotates at uniform speed of 100 r.p.m.; find the maximum velocity and acceleration of a valve during raising and lowering.

Module 3

15) Derive the expression for Length of path of contact, length of arc of contact and contact ratio.

Or

16) In a gear train, as shown in Fig, gear B is connected to the input shaft. The arm A carrying the compound wheels D and E, turns freely on the output shaft. If the input speed is 1200 rpm counter-clockwise, when seen from the right, determine the speed of the output shaft under the following conditions: (a) when the gear C is fixed and (b) when gear C rotates at 10 rpm counter clockwise.



Module 4

17) A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45° , B to C 70° and C to D 120° . The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions.

Or

18) The three cranks of a three-cylinder locomotive are all on the same axle and are set at 120° . The pitch of the cylinders is 1 metre, and the stroke of each piston is 0.6 m. The reciprocating masses are 300 kg for inside cylinder and 260 kg for each outside cylinder and the planes of rotation of the balance masses are 0.8 m from the inside crank. If 40% of the reciprocating parts are to be balanced, find: 1. the magnitude and the position of the balancing masses required at a radius of 0.6 m ; and 2. the hammer blow per wheel when the axle makes 6 r.p.s.

Module 5

19) Derive the response of damped free vibration system for under damping, overdamping, and critical damping conditions.

Or

20) A body having a mass of 15kg is suspended from a spring which deflects 12mm under the weight of the mass. Determine the frequency of free vibrations. What is the viscous damping force needed to make the motion aperiodic at a speed of 1mm/s? If, when damped to this extent, a disturbing force having magnitude value of 100N and vibrating at 6Hz is made to act on the body, determine the amplitude of the ultimate motion.

SYLLABUS

Module 1

Planar Mechanisms-Terminology and definitions. Kinematic pairs, kinematic chains, and degrees of freedom of mechanisms. Kinematic Inversion of 4 bar and slider crank chains. Condition for correct steering. Davis Steering gear and Ackerman Steering gear (No numerical questions).

Brakes-Shoe brakes, Band Brakes, and Internal expanding brakes.

Module 2

Clutches-Single plate clutch, multiplate clutch, cone clutch, and centrifugal clutch.

Cams and followers- Cams - classification of cam and followers - displacement diagrams, velocity, and acceleration analysis of SHM, uniform velocity, uniform acceleration, cycloidal motion. Construction of cam profiles.

Module 3

Gears and Gear Trains- Classification of gears. Terminology and definitions of spur gears. Law of gearing, length of path of contact, arc of contact and contact ratio. Interference and minimum number of teeth to avoid interference. Simple and compound gear trains, planetary gear trains, differential, solution of planetary gear train problems.

Module 4

Flywheels-Turning moment diagrams, fluctuation of energy, flywheel, size of flywheel (No numerical problems).

Balancing of Rotating masses-static and dynamic balancing - balancing of masses rotating in several planes.

Balancing of Reciprocating masses-Balancing of reciprocating masses - balancing of multi-cylinder in line engines – V-engines.

Module 5

Mechanical Vibrations- Free vibrations of single degree freedom systems, energy Method. Undamped and damped free vibrations, viscous damping, critical damping, logarithmic

decrement, harmonically excited vibrations. Response of an undamped and damped system, beat phenomenon, transmissibility. Introduction to multi-degree freedom systems (No numerical Problems). vibration measurement – accelerometer, seismometer.

Text Books

1	Theory of Machines	S S Rattan	Tata McGraw-Hill Publishing Co
2	Theory of Machines: Kinematics and Dynamics	Sadhu Singh	Pearson
3	Theory of Machines	V P Singh	Dhanpat Rai & Co
4	Mechanical Vibrations	V P Singh	Dhanpat Rai & Co

Reference Books

1	Theory of Machines and Mechanism	J E Shigley J J Unicker	Oxford University Press
2	Kinematics and Dynamics of Machinery	Robert L Norton	Tata McGraw-Hill Publishing Co
3	Theory of Machines	Thomas Bevan	Pearson
4	Theory of vibration with applications	W T Thomson	Pearson
5	Dynamics of Machinery	A R Holowenko	John Wiley & Sons

Estd.



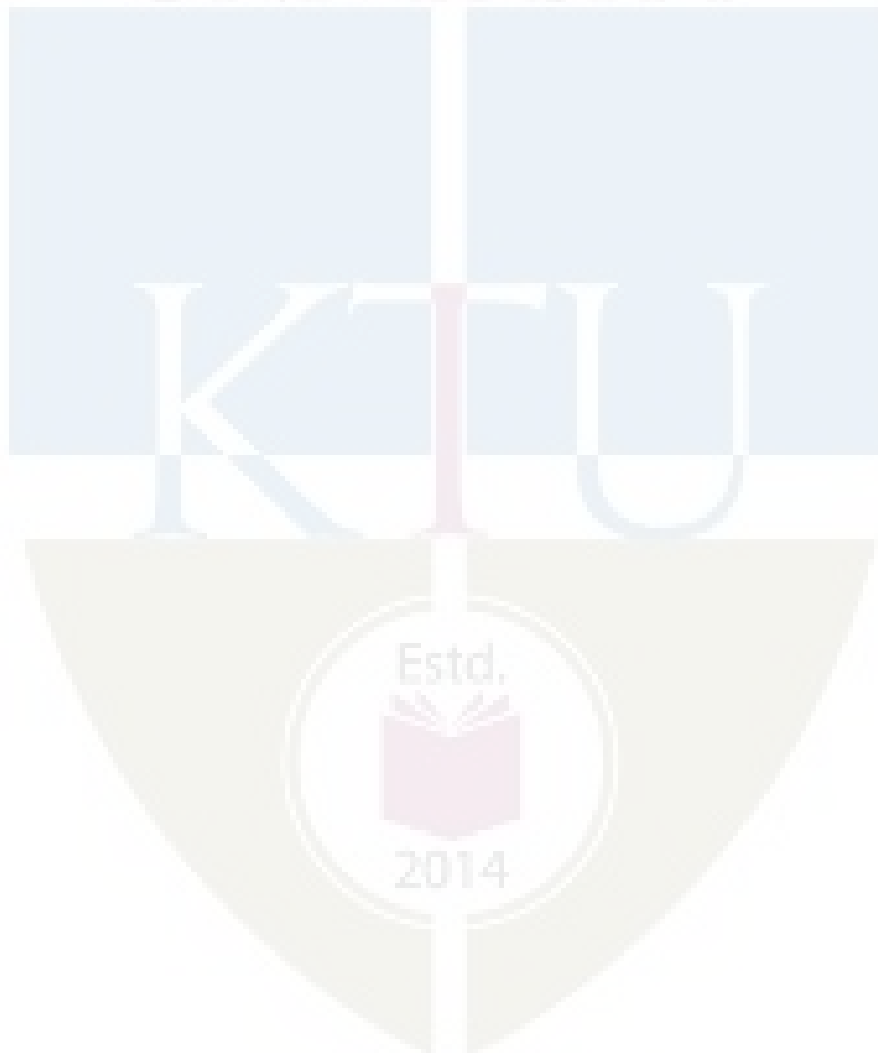
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Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	Module 1 (9 hours)	
1.1	Mechanism, machine, and structure. Kinematic pair, Kinematic Chain and Degrees of freedom of mechanisms.	2
1.2	Kinematic Inversions of 4 bar chain and slider crank chain. Quick return mechanisms.	3
1.3	Condition for correct steering, Davis and Ackerman Steering Gear Mechanisms	1
1.4	Shoe brakes, Band Brakes, and Internal expanding brakes.	3
2	Module 2 (9 hours)	
2.1	Single plate clutch, multiplate clutch, cone clutch, and centrifugal clutch.	4
2.2	Cams - classification of cam and followers - displacement diagrams, velocity, and acceleration analysis of SHM, uniform velocity, uniform acceleration, cycloidal motion. Construction of cam profiles.	5
3	Module 3 (9 hours)	
3.1	Classification of gears. Terminology and definitions of spur gears. Law of gearing.	1
3.2	length of path of contact, arc of contact and contact ratio. Interference and minimum number of teeth to avoid interference.	4
3.3	Simple and compound gear trains, planetary gear trains, differential, solution of planetary gear train problems	4
4	Module 4 (9hours)	
4.1	Turning moment diagrams.	1
4.2	Fluctuation of energy, flywheel and applications, size of flywheel	1
4.3	Balancing of rotating masses, static and dynamic balancing, balancing of rotating masses in several planes.	3
4.4	Balancing of reciprocating masses, balancing of Locomotives, effect of partial balancing in Locomotives, primary and secondary balancing and balancing of inline engines.	3
4.5	Balancing of V Engine.	1
5	Module 5 (9 hours)	
5.1	Vibrations- Definitions, classifications basic elements of vibrational system.	1
5.2	Undamped free vibrations, energy method.	1
5.3	Damped free vibration, equation of motion, response of damped	3

	free vibrations, over damping, under damping and critical damping. Logarithmic decrement.	
5.4	Harmonically excited vibrations, beat phenomenon, magnification factor, transmissibility.	2
5.5	Multi degree of freedom systems, Dunkerley's Method	1
5.6	Vibration measurement-Accelerometer, Seismometer.	1

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MUT 304	COURSE NAME ADVANCED IC ENGINES	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims at providing the students, an insight on the advanced combustion systems and engine technologies.

Prerequisite: NIL

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

CO 1	Understand the modern SI and CI engine combustion technologies.
CO 2	Understand the basics of dual fuel engines and non-conventional engines
CO 3	Understand the concept and working of Lean-burn engines
CO 4	Understand the working principle and operation of stratified charge engines
CO 5	Understand the basic principles, types and operation of LTC concepts and strategies.

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	-	1	1	-	-	2	-	1
CO 2	2	1	-	2	-	1	2	-	-	2	-	1
CO 3	-	1	-	1	-	1	1	-	-	2	-	1
CO 4	-	-	-	-	-	1	1	-	-	2	-	1
CO 5	-	1	-	1	-	2	2	-	-	2	-	3

Assessment Pattern

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

Create			
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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 maximum 2 sub-divisions and carry 14 marks.

Expected outcome:

The students will become aware of the latest developments and advancement in the field of IC engines.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Explain the salient features of HCSI engines.
2. What are the emission control methods used in modern SI engines?
3. Discuss the working of a CRDI engine.
4. What are the different types of electronic diesel injectors?
5. List out the emission control devices in modern diesel engines

Course Outcome 2 (CO2)

1. Distinguish between a duel fuel and multi-fuel engine.
2. What are the factors affecting the performance of a duel fuel engine?
3. List the major difference between a CNG vehicle and a LNG vehicle.
4. Explain how CNG conversion is done?
5. What are the salient features of a FFV?

Course Outcome 3(CO3):

1. Explain the fundamental principle of lean combustion
2. What are the methods used to extend the lean limits?
3. Discuss about LNT technology
4. What are the major components of a gas turbine?
5. Give a comparison of gas turbine and IC engines.

Course Outcome 4 (CO4):

1. What are the methods used for charge stratification?
2. Explain the different combustion modes in a GDI engine.
3. How a TSI engines are more fuel efficient?
4. What are the approaches to auto-ignition combustion operation in gasoline engines?
5. Explain the combustion control methods used in auto-ignition combustion operation in gasoline engines.

Course Outcome 5 (CO5):

1. Explain the principle of operation of a HCCI engine
2. What are the external and internal mixture preparation techniques in LTC engines?
3. What are the combustion control methods used in HCCI engines?
4. What are the features of a RCCI engine?
5. Differentiate between HCCI engine and RCCI engine.

Model Question paper

QP CODE:

PAGES:...

Reg. No: _____

Name : _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: MUT 304

Course Name: ADVANCED IC ENGINES

Max. Marks: 100

Duration: 3 Hours

Part A

(Answer all questions. Each question carries 3 marks)

1. List the emission control methods used in modern SI engines.
2. What are the functions of two oxygen sensors in the exhaust?
3. Give a comparison of super charger and a turbo charger.
4. What is the principle of operation of dual fuel engines?
5. List the main advantages of LNG vehicles compared to CNG vehicles.
6. Discuss the principle of Lean burn engines.
7. Why TSI engines are superior to usual GDI engines?

8. What are the advantages of LTC?
9. How the operational range of HCCI engine can be increased?
10. List down the fuel properties required for RCCI engines.

Part B

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

11. (a) Explain the working of GDI engine with a suitable lay out. (7)
 - (b) Discuss the working of a Lamda sensor. (7)
- OR**
12. With a suitable sketch explain the working of a CRDI system and emission control strategies (14)
 13. Discuss the important factors affecting the performance of a dual fuel engine. (14)
- OR**
14. With a suitable sketch explain the components and working of a CNG vehicle. (14)
 15. Discuss the principle and working of a Lean burn engine (14)
- OR**
16. Explain any two techniques used for increasing the lean operation limits. (14)
 17. Explain the different operational modes of a stratified charge engine? (14)
- OR**
18. What are the different types of gas turbine combustors? Explain their working in detail. (14)
 19. Explain a typical control system employed for four stroke HCCI engine (14)
- OR**
20. Give a brief discussion about the concept and working of an RCCI engine. Also give a comparison between HCCI and RCCI engine. (14)

SYLLABUS

Module 1

Advanced Spark-Ignition Engines - Homogenous-Charge Spark-Ignition (HCSI) Engines, Equivalence Ratio and Engine Emissions in HCSI engines, Combustion Duration in HCSI Engines, Hydrogen in Spark-Ignited Engines, emission control devices in modern SI engines
 Advanced Diesel engines- High pressure CRDI, Components of CRDI system- pump, rail, rail pressure sensor, rail pressure control valve, electronic injectors- types, pulse width, duty cycle, multiple injection diesel combustion, UPCR, turbo chargers-types, components, EGR, emission control devices in modern diesel engines.

Module 2

Dual fuel engine concepts and significance, factors affecting combustion in dual fuel engines, performance of dual fuel engines. Multifuel engines, characteristics of multi fuel engines,

performance of multi fuel engines.

CNG and LNG engines – Direct injection natural gas engines - technologies–potential applications–strength and weakness, CNG conversion – future trends

Non-conventional engines- Wankel engine, Stirling engine- free piston engine, VCR engines, flexi fuel *engines* (FFV).

Module 3

Lean burn engines–fundamentals of lean combustion–lean burn SI engines –engine combustion and emissions– lean limit operations, Extending the Lean Limit of Spark-Ignited Engine Operation- Through Increased Turbulence Generation, Through Partial Stratification, Using Microwave-Assisted Spark Ignition, LNT technology.

Gas turbines- components and working, Gasturbine as automotive engine– Limitations of gasturbine in automotive sector. Comparison of gas turbine with I.C engine.

Module 4

Stratified charge combustion in direct injection SI engines – GDI engines combustion process–Turbocharged direct injection SI engines (TSI) –problems and challenges– advantages– future trends

Direct injection gasoline engines with auto ignition combustion – principles and approaches– operation and control – development of practical engines–future trends.

Module 5

Low Temperature Combustion Strategies- Types, Principle, advantages, HCCI and CAI engines – fundamentals – external and internal mixture preparation techniques, effect of use of exhaust gas dilution – approaches to CAI/HCCI – Two stroke CAI engines – principles – control – potential applications – four stroke gasoline and diesel HCCI engines – HCCI fuel requirements – low temperature and premixed combustion with late injection – NADI concept of HCCI – CAI control and CAI/SI switching, Concept and working of dual fuel reactivity controlled compression ignition (RCCI) engine.

Text Books:

1. HZhao, Advanced Direct Injection Combustion Engine Technologies and Development, volume1-gasoline and gas engines, Wood head publishing, 2009.
2. H Zhao, Advanced Direct Injection Combustion Engine Technologies and Development, volume2-dieselengines, Wood head publishing, 2009

Reference Books

1. H Zhao , HCCIand CAI Engines for the Automotive Industry, Woodhead publishing
2. DerekDunn -Rankin,Lean Combustion:Technology and Control, Academic press, 2007
3. M.L. Mathur, R. P. Sharma-Internal Combustion Engines, Dhanpat RaiPublications.

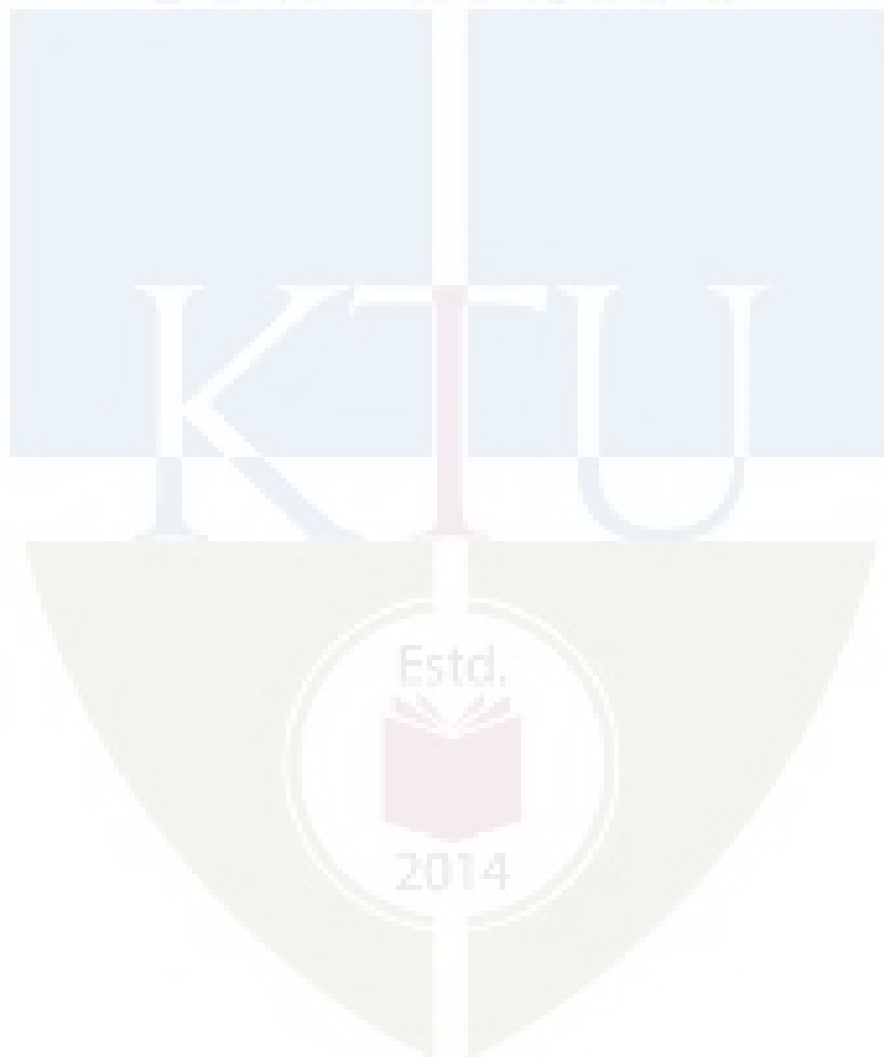
4. VGanesan, *Internal Combustion Engine* Tata McGraw Hill Publishing Company Ltd., New Delhi 2006.
5. Rapp, V., Killingsworth, N., Therkelsen, P., & Evans, R. (2016). *Lean-Burn Internal Combustion Engines. Lean Combustion, 111–146.* doi:10.1016/b978-0-12-804557-2.00004-3, 2016 Elsevier Inc.

Course Contents and Lecture Schedule

No	Topics	No. of Lectures
1	MODULE – 1:	
1.1	Advanced Spark-Ignition Engines - Homogenous-Charge Spark-Ignition (HCSI) Engines	2
1.2	Equivalence Ratio and Engine Emissions in HCSI engines, Combustion Duration in HCSI Engines	1
1.3	Hydrogen in Spark-Ignited Engines,	1
1.4	emission control devices in modern SI engines	1
1.5	Advanced Dieselen-gines- High pressure CRDI, Components of CRDI system- pump, rail, rail pressure sensor, rail pressure control valve	1
1.6	Electronic injectors- types, pulse width, duty cycle, multiple injection diesel combustion	1
1.7	UPCR, turbo chargers-types, components, EGR	1
1.8	Emission control devices in modern diesel engines.	1
2	MODULE – 2:	
2.1	Dual fuel engine concepts and significance, factors affecting combustion in dual fuel engines	1
2.2	Performance of dual fuel engines.	1
2.3	Multifuel engines, characteristics of multifuel engines, performance of multifuel engines.	1
2.4	CNG and LNG engines – Direct injection natural gas engines technologies, CNG conversion	1
2.5	CNG and LNG engines –potential applications–strength and weakness– future trends	1
2.6	Non-conventional engines- Wankel engine	1
2.7	Stirling engine- free piston engine,	1
2.8	VCR engines,	1
2.9	Flexifuel engines (FFV).	1
3	MODULE – 3:	
3.1	Lean burn engines–fundamentals of lean combustion–lean burn SI engines –engine combustion and emissions–	1

3.2	Lean burn engines–lean limit operations, Extending the Lean Limit of Spark-Ignited Engine Operation- Through Increased Turbulence Generation	1
3.3	Extending the Lean Limit of Spark-Ignited Engine Operation- Through Partial Stratification, Using Microwave-Assisted Spark Ignition, LNT technology.	1
3.4	Extending the Lean Limit of Spark-Ignited Engine Operation- Through Microwave-Assisted Spark Ignition	1
3.5	LNT technology.	1
3.6	Gasturbines- components and working	1
3.7	Gasturbines- components and working - continued	1
3.8	Gasturbine as automotive engine– Limitations of gasturbine in automotive sector.	1
3.9	Comparison of gas turbine with I.C engine.	1
4	MODULE – 4:	
4.1	Stratified charge combustion in direct injection SI engines	1
4.2	GDI engines combustion process	1
4.3	Turbocharged direct injection SI engines (TSI)	1
4.4	Turbocharged direct injection SI engines (TSI) –problems and challenges– advantages–future trends	1
4.5	Direct injection gasoline engines with autoignition combustion	1
4.6	Direct injection gasoline engines with autoignition combustion – principles and approaches	1
4.7	Direct injection gasoline engines with autoignition combustion operation and control	1
4.8	Direct injection gasoline engines with auto ignition combustion – development of practical engines	1
4.9	Direct injection gasoline engines with auto ignition combustion – future trends.	1
5	MODULE – 5:	
5.1	Low Temperature Combustion Strategies- Types, Principle	1
5.2	Low Temperature Combustion Strategies-advantages,	1
5.3	HCCI and CAI engines – fundamentals – external and internal mixture preparation techniques,	1
5.4	Effect of use of exhaust gas dilution – approaches to CAI/HCCI	1
5.5	Two stroke CAI engines – principles – control – potential applications	

5.6	Four stroke gasoline and diesel HCCI engines – HCCI fuel requirements	1
5.7	Low temperature and premixed combustion with late injection – NADI concept of HCCI	1
5.8	CAI control and CAI/SI switching	1
5.9	Concept and working of dual fuel reactivity controlled compression ignition (RCCI) engine.	1



MUT 306	AUTO COMPONENT DESIGN	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: The aim of this subject is to offer the students a general understanding of various automotive components design.

- Explain concepts of mechanics of solids and fundamental approaches to failure prevention.
- To provide basic design methods for shafts, keys and springs.
- To provide basic design methods for clutches, brakes and bearings.
- To provide basic design methods for gear.
- To provide basic design methods for internal combustion engine parts.

Prerequisite :- MET 201: Mechanics of Solids/ MUT206: Mechanics of Solids

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

CO 1	Understand the concepts of mechanics of solids and failure prevention of components.
CO 2	Apply the basic design methods for shafts, keys and bearings.
CO 3	Apply the basic design methods for clutches, brakes and springs.
CO 4	Apply the basic design methods for gears.
CO 5	Apply the basic design methods for internal combustion engine parts.

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	-	-	2	-	-	-	-	-	-	-	1
CO 2	1	-	3	2	-	-	-	-	-	-	-	2
CO 3	1	-	3	2	-	2	-	-	-	-	-	2
CO 4	1	-	3	2	-	-	-	-	-	-	-	2
CO 5	1	-	3	2	-	2	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember			
Understand	10	10	20
Apply	20	20	60
Analyse	20	20	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE (Continuous Internal Evaluation)	ESE (End Semester Examination)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation (CIE) Pattern:

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

End Semester Examination (ESE) Pattern:

There will be two questions, each carrying 20 marks from all the modules. The student need to attend ONE question from each module

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Explain the concept of mechanics of solids.
2. Describe the fundamental approaches to failure prevention of components.
3. Explain theories of failure

Course Outcome 2 (CO2)

1. Illustrate the basic design procedure for shafts.
2. Interpret the basic design procedure for keys.
3. Extrapolate the basic design procedure of bearings.

Course Outcome 3(CO3):

1. Employ the basic design procedure of clutch.
2. Enumerate the basic design procedure for automotive brakes.
3. Estimate the basic design procedure of springs.

Course Outcome 4 (CO4):

1. Illustrate the basic design procedure for spur gears.
2. Illustrate the basic design procedure for helical gears.
3. Illustrate the basic design procedure for bevel gears.

Course Outcome 5 (CO5):

1. Demonstrate the basic design procedure of internal combustion engine parts.

Model Question paper**QP CODE:****PAGES:3****Reg. No:** _____**Name :** _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: AUT 306**Course Name: AUTOMOTIVE COMPONENTS DESIGN****Max. Marks: 100****Duration: 3 Hours****Answer any FIVE****Each question carries 20 mark marks.****Module 1**

1. (a) Suggest suitable materials for the following parts stating the special property which makes it more suitable for use in manufacturing: 1. Diesel engine crankshaft, 2. Automobile tyres, 3. Roller bearings 4. High pressure steam pipes 5. Stay bar of boilers 6. Worm and worm gear 7. Dies; 8. Tramway axle 9. Cam follower 10. Hydraulic brake piston. (10)
- (b) Explain in detail about,
 - i. Von Mises and Hencky Theory. (5)
 - ii. St. Venant's Theory (5)

OR

2. A shaft is supported on two bearings 1m apart. A 60mm diameter pulley is mounted 300mm to the right of left bearing and this drives a pulley directly below it with the help of a belt having maximum tension of 2.25kN. Another pulley 400mm diameter is driven by a motor and belt is located at a distance of 200mm to the left of right bearing. The motor is placed horizontally to the right of the system. The angle of contact of both the pulleys is 180° and the co-efficient of friction is 0.24. Determine the diameter of the shaft considering that both the pulleys are operated at same torque and the shaft material has a tensile stress of 63MPa and shear stress of 42MPa. (20)

Module 2

3. A steel solid shaft transmitting 15 kW at 200 r.p.m. is supported on two bearings 750 mm apart and has two gears keyed to it. The pinion having 30 teeth of 5 mm module is located 100 mm to the left of the right hand bearing and delivers power horizontally to the right. The gear having 100 teeth of 5 mm module is located 150 mm to the right of the left hand bearing and receives power in a vertical direction from below. Using an allowable stress of 54 MPa in shear, determine the diameter of the shaft. (20)

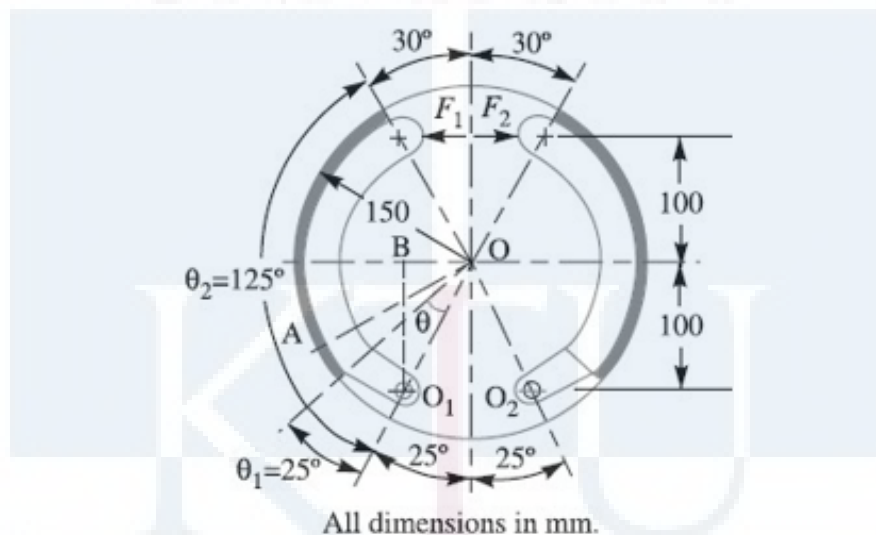
OR

4. A shaft rotating at constant speed is subjected to variable load. The bearings supporting

the shaft are subjected to stationary equivalent radial load of 3 kN for 10 per cent of time, 2 kN for 20 per cent of time, 1 kN for 30 per cent of time and no load for remaining time of cycle. If the total life expected for the bearing is 20×10^6 revolutions at 95 per cent reliability, calculate dynamic load rating of the ball bearing. (20)

Module 3

5. The figure shows an internal expanding brake system. The brake drum radius is 150mm. The intensity of pressure at any point is given by $0.4\sin\theta$ N/mm² and the co-efficient of friction is 0.4. Width (b) of the brake lining is 35mm. Determine the braking torque and forces F_1 and F_2 and the torque capability of the brakes. Suggest a suitable type of vehicle for which this brakes can be employed (20)



Or

6. Design a helical spring for a spring-loaded safety valve (Ramsbottom safety valve) for the following conditions : Diameter of valve seat = 65 mm ; Operating pressure = 0.7 N/mm²; Maximum pressure when the valve blows off freely = 0.75 N/mm²; Maximum lift of the valve when the pressure rises from 0.7 to 0.75 N/mm² = 3.5 mm ; Maximum allowable stress = 550 MPa ; Modulus of rigidity = 84 kN/mm²; Spring index = 6. Draw a neat sketch of the free spring showing the main dimensions. (20)

Module 4

7. A bronze spur pinion rotating at 600 r.p.m. drives a cast iron spur gear at a transmission ratio of 4 : 1. The allowable static stresses for the bronze pinion and cast-iron gear are 84 MPa and 105 MPa, respectively. The pinion has 16 standard 20° full depth involute teeth of module 8 mm. The face width of both the gears is 90 mm. Find the power that can be transmitted from the standpoint of strength. (20)

Or

8. A motor shaft rotating at 1500 r.p.m. has to transmit 15 kW to a low-speed shaft with a speed reduction of 3:1. The teeth are 14.5° involute with 25 teeth on the pinion. Both the pinion and gear are made of steel with a maximum safe stress of 200 MPa. A safe stress of 40 MPa may be taken for the shaft on which the gear is mounted and for the key. Design a spur gear drive to suit the above conditions. Also sketch the spur gear drive. Assume starting torque to be 25% higher than the running torque. (20)

Module 5

9. Design a cast iron piston for a single acting four stroke engine for the following data: Cylinder bore = 100 mm ; Stroke = 125 mm ; Maximum gas pressure = 5 N/mm² ; Indicated mean effective pressure = 0.75 N/mm² ; Mechanical efficiency = 80% ; Fuel consumption = 0.15 kg per brake power per hour ; Higher calorific value of fuel = 42 × 10³ kJ/kg ; Speed = 2000 r.p.m. Any other data required for the design may be assumed. (20)

OR

10. Design a side or overhung crankshaft for a 250 mm × 300 mm gas engine. The weight of the flywheel is 30 kN and the explosion pressure is 2.1 N/mm². The gas pressure at the maximum torque is 0.9 N/mm², when the crank angle is 35° from I. D. C. The connecting rod is 4.5 times the crank radius. (20)

SYLLABUS

Module 1

Introduction to Design- Definition, steps in design process, preferred numbers, standards and codes in design. Materials and their properties- Elastic and plastic behaviour of metals, ductile and brittle behaviour, shear, bending and torsional stresses, combined stresses, stress concentration factor.

Theories of Failure- Guest's Theory, Rankine's Theory, St. Venant's Theory, Haigh's Theory, and Von Mises and Hencky Theory. Shock and impact loads, fatigue loading, endurance limit stress, factors affecting endurance limit, factor of safety.

Module 2

Shafting- material, design considerations, causes of failure in shafts, design based on strength, rigidity and critical speed, design for static and fatigue loads, repeated loading, reversed bending. Design of woodruff key and splines

Rolling contact bearing- Design of bearings, Types, Selection of a bearing type, bearing life, static and dynamic load capacity, axial and radial loads, selection of bearings, dynamic equivalent load.

Sliding contact bearing- lubrication, lubricants, viscosity, Journal bearings, hydrodynamic theory, Sommerfield number, design considerations.

Module 3

Clutches – friction clutches, design considerations, multiple disc clutches, cone clutch, centrifugal clutch.

Brakes - Internal expanding shoe brake, Disc brakes.

Springs- classification, spring materials, stresses and deflection of helical springs, axial loading, curvature effect, resilience, static and fatigue loading, surging, critical frequency, end construction. design of leaf springs, design of torsion bar

Module 4

Gears- classification, Gear nomenclature, Tooth profiles, Materials of gears, Law of gearing (review only), virtual or formative number of teeth, gear tooth failures, Beam strength, Lewis equation, Buckingham's equation for dynamic load, wear load, endurance strength of tooth, surface durability, heat dissipation – Design of spur gear, helical gear and bevel gears

Module 5

Design of Internal combustion engine parts- Crankshaft, Piston, Cylinder, Connecting rod and Flywheel.

Textbooks

- 1, T Krishnarao, Design of Machine Elements Vol 1 and 2, I K International Publishing House, 2008
- 2 S Md Jalaludeen, Machine Design, Anuradha Publishers, 2016
- 3, V.B.Bhandari, Design of Machine elements, McGraw Hill, 2016
4. R. L. Norton, Machine Design – An Integrated Approach, Pearson Education, 2001

Reference Books

- 1, Rajendra Karwa, Machine Design, Laxmi Publications (P) LTD, New Delhi, 2006
- 2, J. E. Shigley, Mechanical Engineering Design, McGraw Hill book company
- 3, Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley, 2011

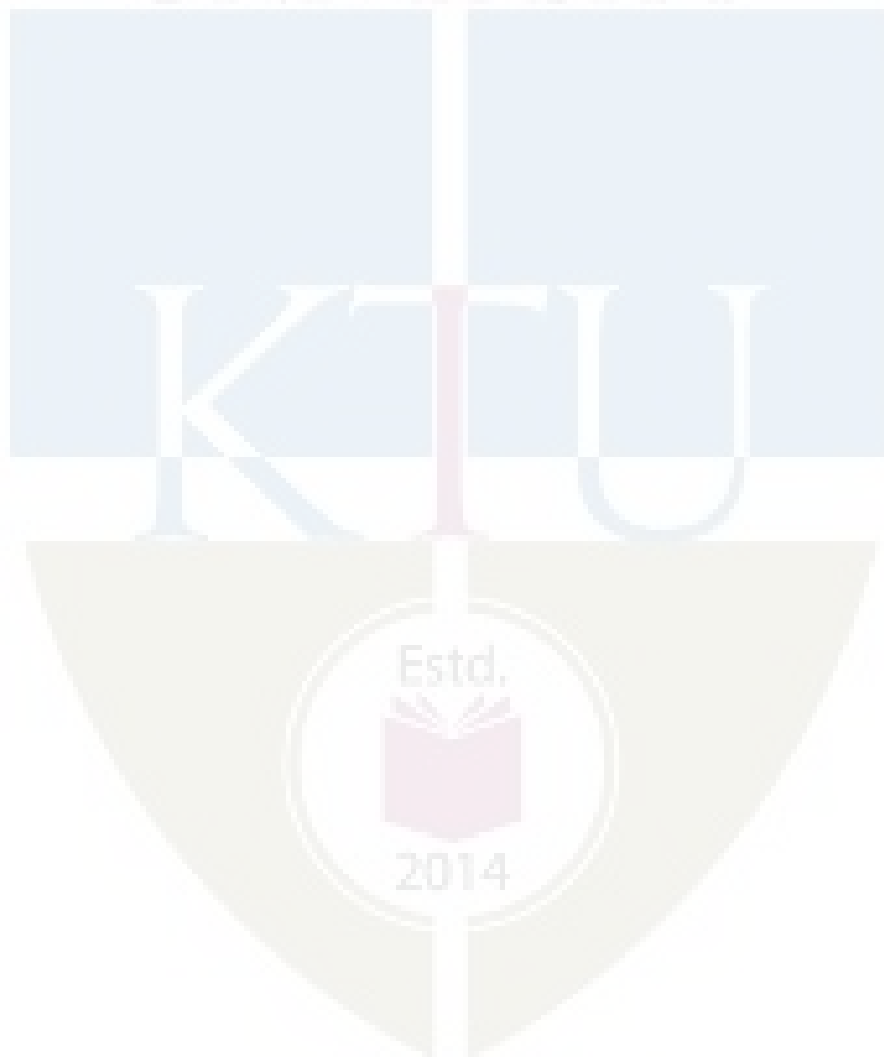
Databook

- 1, Narayana Iyengar B.R & Lingaiah K, Machine Design Data Handbook,, Tata McGraw Hill, 1984
- 2, PSG Design Data, Design Data Handbook, DPV Printers, Coimbatore, 2012

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	Module 1 (9 hours)	
1.1	Introduction to Design- Definition, steps in design process, preferred numbers, standards and codes in design.	2
1.2	Materials and their properties- Elastic and plastic behaviour of metals, ductile and brittle behaviour.	2
1.3	Shear, bending and torsional stresses, combined stresses, stress concentration factor.	2
1.4	Theories of Failure- Guest's Theory, Rankine's Theory, St. Venant's Theory, Haigh's Theory, and Von Mises and Hencky Theory.	2
1.5	Shock and impact loads, fatigue loading, endurance limit stress, factors affecting endurance limit, factor of safety.	1
2	Module 2 (10 hours)	
2.1	Shafting- material, design considerations, causes of failure in shafts, design based on strength, rigidity and critical speed.	2
2.2	Design for static and fatigue loads, repeated loading, reversed bending.	1
2.3	Design of woodruff key and splines.	2
2.4	Rolling contact bearing- Design of bearings, Types, Selection of a bearing type, bearing life, static and dynamic load capacity, axial and radial loads, selection of bearings, dynamic equivalent load.	3
2.5	Sliding contact bearing- lubrication, lubricants, viscosity, Journal bearings, hydrodynamic theory, Sommerfield number, design considerations.	2
3	Module 3 (10 hours)	
3.1	Clutches – friction clutches, design considerations.	1
3.2	Multiple disc clutches, cone clutch, centrifugal clutch.	2
3.3	Brakes - Block brakes, band brake, Internal expanding shoe brake.	2
3.4	Springs- classification, spring materials, stresses and deflection of helical springs, axial loading.	2
3.5	Curvature effect, resilience, static and fatigue loading, surging, critical frequency, end construction.	1
3.6	Design of leaf springs.	2
4	Module 4 (10hours)	
4.1	Gears- classification, Gear nomenclature, Tooth profiles, Materials of gears, Law of gearing (Revision)	1
4.2	Static and dynamic design of spur gears	3
4.3	Static and dynamic design of helical gears	3

4.4	Static and dynamic design of bevel gears	3
5	Module 5 (10 hours)	
5.1	Design of crankshaft	2
5.2	Design of Piston.	2
5.2	Design of Cylinder.	2
5.3	Design of Connecting rod.	2
5.4	Design of Flywheel.	2



MUT308	COMPREHENSIVE COURSE WORK	CATEGORY	L	T	P	CREDIT
		PCC	1	0	0	1

Preamble: The aim of this subject is to evaluate the overall understanding of the students in the core areas of Mechanical Automobile Engineering Program.

- ✓ To assess the comprehensive knowledge gained in basic courses relevant to the branch of study
- ✓ To prepare the student to appear for competitive exams with questions asked in relevant field and answer them with confidence.

Prerequisite:

MUT203 Auto Chassis

MET202 Engineering Thermodynamics

MUT301 Auto Electrical And Electronics

MUT307 Auto Transmission

MUT305 Vehicle Dynamics

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

CO 1	Learn to prepare for a competitive examination
CO 2	Comprehend the questions in Automobile & Mechanical Engineering field and answer them with confidence
CO 3	Communicate effectively with faculty in scholarly environments
CO 4	Analyse the comprehensive knowledge gained in basic courses in the field of Mechanical Engineering

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
	MCQ
Remember	25
Understand	15
Apply	5
Analyse	5
Evaluate	
Create	

Mark distribution

Total Marks	ESE	ESE Duration
50	50	1 hour

End Semester Examination Pattern: A written examination will be conducted by the University at the end of the sixth semester for 50 marks. The written examination will be of objective type. Syllabus for the comprehensive examination is based on following five Mechanical (Automobile) Engineering core courses from semester 3 to semester 5.

MUT203 Auto Chassis

MET202 Engineering Thermodynamics

MUT301 Auto Electrical and Electronics

MUT307 Auto Transmission

MUT305 Vehicle Dynamics

The written test will be of 50 marks with 50 multiple choice questions (10 questions from each core course) with 4 choices of 1 mark each covering all the five core courses. There will be no negative marking. The pass minimum for this course is 25. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed above.

SYLLABUS

SUBJECT WILL BE COVERING THE SYLLABUS OF FOLLOWING SUBJECTS

MUT203 AUTO CHASSIS

MET202 ENGINEERING THERMODYNAMICS

MUT301 AUTO ELECTRICAL AND ELECTRONICS

MUT307 AUTO TRANSMISSION

MUT305 VEHICLE DYNAMICS

Model Question paper

Course Code: MUT 308				
Course name: COMPREHENSIVE EXAM – MECHANICAL (AUTO) ENGG (MU)				
Max. Marks: 50		Duration: 1 Hour		
Instructions:				
<p>(1) Each question carries one mark. No negative marks for wrong answers</p> <p>(2) Total number of questions: 50</p> <p>(3) All questions are to be answered. Each question will be followed by 4 possible answers of which only ONE is correct.</p> <p>(4) If more than one option is chosen, it will not be considered for valuation.</p> <p>(5) Calculators are not permitted</p>				
PART B- CORE COURSES				
1.	Transaxles used in drive type vehicle layout			
	a)	Front wheel	b)	Rear wheel
			c)	Four wheel
			d)	Multi-axle
2.	The entry of air bubbles in the hydraulic brake lines lead to			
	a)	Brake drag	b)	Brake fade
			c)	Spongy brake
			d)	None of these
3.	Modern coaches uses type of body construction			
	a)	Conventional	b)	Integral
			c)	Lift back
			d)	Tandem axle
4.	Transaxles used in drive type vehicle layout.			
	a)	Front wheel	b)	Rear wheel
			c)	Four wheel
			d)	Multi-axle
5.	The entry of air bubbles in the hydraulic brake lines lead to			
	a)	Brake drag	b)	Brake fade
			c)	Spongy brake
			d)	None of these
6.	The relative motions between sun gear and planetary gear will occur in a differential only during			
	a)	Braking	b)	Taking a turn
			c)	Accelerating
			d)	Straight ahead
7.	The distance between the point at which the steering axis meet the ground and the centre of the same wheel tread is referred as....			
	a)	Wheel radius	b)	Steering angle
			c)	Scrub radius
			d)	Wheel track
8.	The change in between front axle and rear axle lead to under steer and over steer.			
	a)	Wheel base	b)	Wheel track
			c)	Slip angle
			d)	None of these
9.	The change in between front axle and rear axle lead to under steer and over			

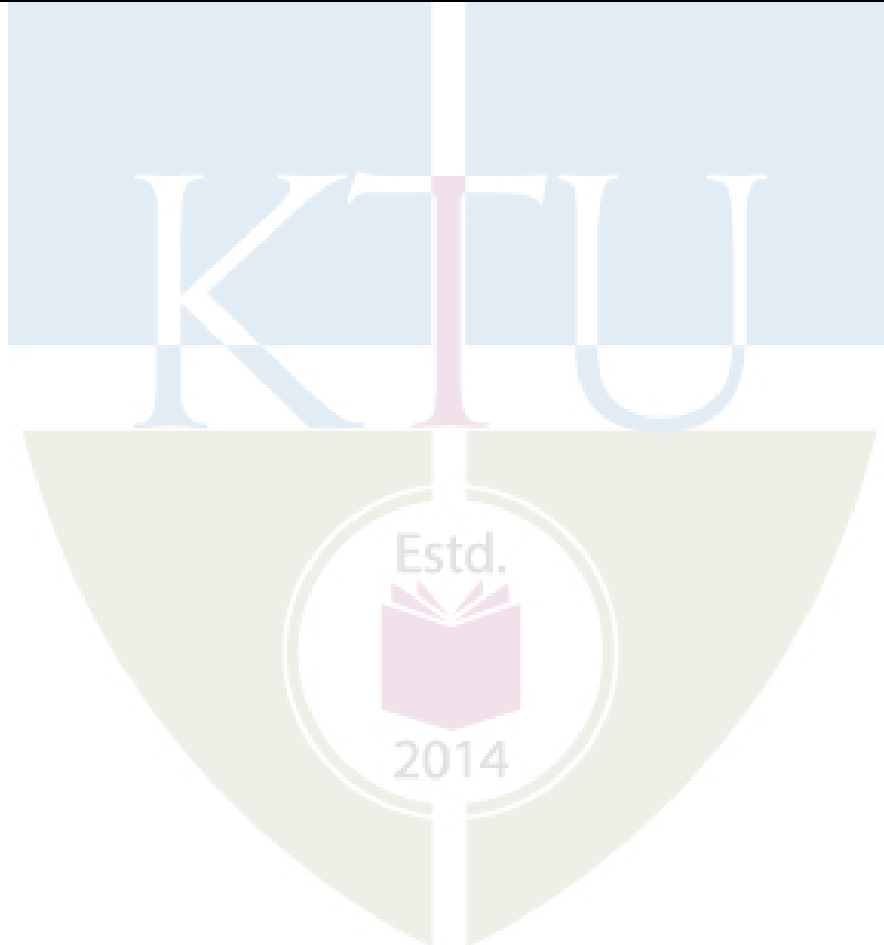
	steer.			
	a) Wheel base	b) Wheel track	c) Slip angle	d) None of these
10.	The amount of front wheel tilt measured in degrees from the vertical, is called			
	a) camber angle	b) caster angle	c) toe-in	d) toe-out
11.	In which thermodynamic process is there no flow of heat between the system and surroundings.			
	a) Isobaric	b) Isochoric	c) Adiabatic	d) Isothermal
12.	A definite area or space where some thermodynamic process takes place is known as			
	a) thermodynamic system	b) thermodynamic cycle	c) thermodynamic process	d) thermodynamic law
13.	The temperature at which the volume of a gas becomes zero is called			
	a) absolute scale of temperature	b) absolute zero temperature	c) absolute temperature	d) none of the above
14.	A series of operations, which take place in a certain order & restore the initial condition is known as			
	a) reversible cycle	b) irreversible cycle	c) thermodynamic cycle	d) none of the above
15.	According to kinetic theory of heat			
	a) temperature should rise during boiling	b) temperature should fall during freezing	c) at low temperature all bodies are in solid state	d) at absolute zero there is absolutely no vibration of molecules
16.	A system comprising a single phase is called a			
	a) closed system	b) open system	c) isolated system	d) homogeneous system
17.	Internal energy of a perfect gas depends on			
	a) temperature, specific heats & pressure	b) temperature, specific heats & enthalpy	c) temperature, specific heats & entropy	d) temperature only
18.	Which of the following is not a property of the system			
	a) temperature	b) pressure	c) specific volume	d) heat
19.	The process or systems that do not involve heat are called			

	a)	isothermal processes	b)	equilibrium processes	c)	adiabatic processes	d)	steady processes
20.	The condition for the reversibility of a cycle is							
	a)	the pressure & temperature of the working substance must not differ, appreciably	b)	all the processes, taking place in the cycle of operation, must be extremely slow	c)	the working parts of the engine must be friction free	d)	all of the above
21.	Which of the following is the advantage of alkaline battery?							
	a)	High energy density	b)	Good discharge characteristics over a wide range of temperature	c)	The specific gravity of electrolyte remains the same	d)	Cheap raw materials are used
22.	What is a maintenance-free battery?							
	a)	A battery having lead-antimony plate grid	b)	A battery having lead-calcium plate grid	c)	A battery does not contain acid	d)	A battery does not contain water
23.	The basic purpose of the overrunning clutch in the starter drive is to:							
	a)	assist the solenoid during cranking.	b)	pull the starter pinion gear out of mesh.	c)	disengage the armature when the engine starts	d)	keep the hold-in winding energized during cranking
24.	A solenoid uses two coils. Their windings are called							
	a)	push-in and pull-out.	b)	pull-in and push-out.	c)	push-in and hold-out.	d)	pull-in and hold-in
25.	The drive shaft in distributor is rotated at ___ the engine speed in four stroke engine							
	a)	half	b)	equal to	c)	one and half times	d)	double
26.	The sensor used to measure the oxygen content in exhaust is							
	a)	MAP Sensor	b)	Throttle Position Sensor	c)	Knock Sensor	d)	Lambda Sensor
27.	The rpm of the engine is given by							

	a)	Speedometer	b)	Odometer	c)	tachometer	d)	monometer
28.	The system which provides the direction in which the vehicle is taking a curve is							
	a)	Head Light	b)	Rear Light	c)	Directional Indicator	d)	Side Light
29.	Single point of injection in SI Engine is							
	a)	MPFI	b)	TBI	c)	GDI	d)	CRDI
30	The pressure in which fuel is injected in CRDI engine is							
	a)	100 bar	b)	200 bar	c)	500 bar	d)	Above 1000 bar
31	Cushioning springs in clutch plate are meant to reduce							
	a)	Noisy operation	b)	Jerky starts	c)	Vehicle speed	d)	none of the above
32	The clutch is located between the transmission and the							
	a)	Engine	b)	Rear axle	c)	Differentia	d)	Propeller Shaft
33	Clutch facings are attached to plates by							
	a)	Steel screws	b)	Aluminium screws	c)	Brass trivets	d)	None of these
34	The purpose of transmission in an automobile is							
	a)	To vary speed of engine	b)	To vary power of engine	c)	To vary the power of automobile	d)	To vary the torque at road wheels
35	The central gear of an epicyclic gear set is called							
	a)	Ring gear	b)	Planet gear	c)	Sun gear	d)	None of the above
36	The component of torque converter that drives the oil is							
	a)	Turbine	b)	Impeller	c)	Stator	d)	None of these
37	The blades in a torque converter have a shape which is							
	a)	Square	b)	Round	c)	Flat	d)	Curved
38	Why are the helical gears used commonly in transmission over spur gears?							
	a)	Low cost and high strength	b)	Low noise level and high strength	c)	Low noise level and economy	d)	Low noise level and low cost
39	In which of the configuration of epicyclic gearbox output will be forward and fast output speed?							
	a)	Sun gear stationary, ring gear driven,	b)	Sun gear driving, ring gear driven,	c)	Sun gear driven, ring gear stationary,	d)	Sun gear stationary, ring gear stationary,

		planet carrier driving		planet carrier stationary		planet carrier driving		planet carrier driving
40.	Automatic transmission does not have the following component							
	a)	Epicyclic Gear Train	b)	Torque Converter	c)	TCC Solenoid	d)	Synchromesh Gear Box
41.	What is the relation between overturning couple and balancing couple for the stability of vehicle?							
	a)	Independent of each other	b)	Overturning couple is greater	c)	Balancing couple is greater	d)	Equal to each other
42.	A traction control system (TCS) in automobiles controls the							
	a)	Vibrations on the steering wheel	b)	Engine power during acceleration	c)	Torque that is transmitted by the tyres to the road surface	d)	Stopping distance in case of emergency
43.	The stopping sight distances(S) of a vehicle for Indian highways is given by: (Here V is the speed of the vehicle, t is the brake reaction time and η is the efficiency of brakes)							
	a)	$S = 0.28V \cdot t + \frac{0.01V^2}{\eta}$	b)	$S = 0.28V \cdot t + \frac{0.01\eta}{V^2}$	c)	$S = 0.01V \cdot t + \frac{0.28V^2}{\eta}$	d)	$S = 0.01V \cdot t + \frac{0.28\eta}{V^2}$
44.	For a car traveling with speed v around a curve of radius r, determine a formula for the angle at θ which a road should be banked so that no friction is required							
	a)	$\tan\theta = V^2/rg$	b)	$\sin\theta = V/rg$	c)	$\tan\theta = V/rg$	d)	$\cos\theta = V^2/rg$
45.	Rolling resistance of wheels depends upon i) vehicle load ii) Grade iii) Ground conditions. Of these statement							
	a)	only i) is correct	b)	i) and ii) are correct	c)	i) and iii) are correct	d)	ii) and iii) are correct
46.	What is called the cornering force over the slip angle?							
	a)	Castor trail	b)	Cornering power	c)	Self-righting torque	d)	Pneumatic trail
47.	A combination of roll and pitch is called							
	a)	Circular pitch	b)	Lateral pitch	c)	Transverse pitch	d)	Diagonal pitch
48.	What happens when air struggles to fill the void left behind a car that's moving forward?							
	a)	The low-pressure area behind the car	b)	The air rushes into the void and pushes the	c)	The low-pressure area creates lift that	d)	All of the above

	"pulls" on the car, creating drag.		car forward.		reduces the traction of the rear tires.			
49.	A portion of the underbody of a car which is shaped to create a location of increasingly larger air volume below the rear is called:							
	a)	Air dams	b)	Splitter	c)	Diffuser	d)	Spoiler
50.	When is the positive sign used for the expression of gyroscopic couple?							
	a)	Centre of gravity is lower than the centre of vehicle	b)	When the engine is rotating in the opposite direction as that of wheels	c)	When the engine is rotating in the same direction as that of wheels	d)	Centre of gravity is higher than vehicle centre



MEL332	COMPUTER AIDED DESIGN AND ANALYSIS LAB	CATEGORY	L	T	P	CREDITS
		PCC	0	0	3	2
Preamble:						
<ul style="list-style-type: none"> To introduce students to the basics and standards of engineering design and analysis related to machine components. To make students familiarize with different solid modelling and analysis soft wares To convey the principles and requirements of modelling and analysis of machine elements. To introduce the preparation of part modelling and assembly modelling of machineries To introduce standard CAD packages to perform Finite Element Analysis of machine parts 						
Prerequisite:						
EST 110 - Engineering Graphics						
MEL 201 - Computer Aided Machine Drawing						
Course Outcomes - At the end of the course students will be able to						
CO1	Gain working knowledge in Computer Aided Design and modelling procedures.					
CO2	Gain knowledge in creating solid machinery parts.					
CO3	Gain knowledge in assembling machine elements.					
CO4	Gain working knowledge in Finite Element Analysis.					
CO5	Solve simple structural, heat and fluid flow problems using standard software					

Mapping of course outcomes with program outcomes (Minimum requirements)

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

Mark Distribution

Total Marks	CIE Marks	ESE marks	ESE duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	15 marks
Regular class work/Modelling and Analysis/Lab Record and Class Performance	30 marks
Continuous Assessment Test (minimum two tests)	30 marks

Continuous Assessment test pattern

Bloom's Taxonomy	Continuous Assessment Tests	
	Test 1 - PART A MODELLING (marks)	Test 2 - PART B ANALYSIS (marks)
Remember	10	10
Understand	10	10
Apply	20	20
Analyse	15	15
Evaluate	20	20
Create	25	25

End semester examination pattern

End semester examination shall be conducted on modelling and analysis and based on complete syllabus. The following general guidelines should be maintained for the award of marks

- Part A Assembly Modelling – 35 marks
- Part B Analysis – 30 marks
- Viva Voce – 10 marks.

Conduct of University Practical Examinations

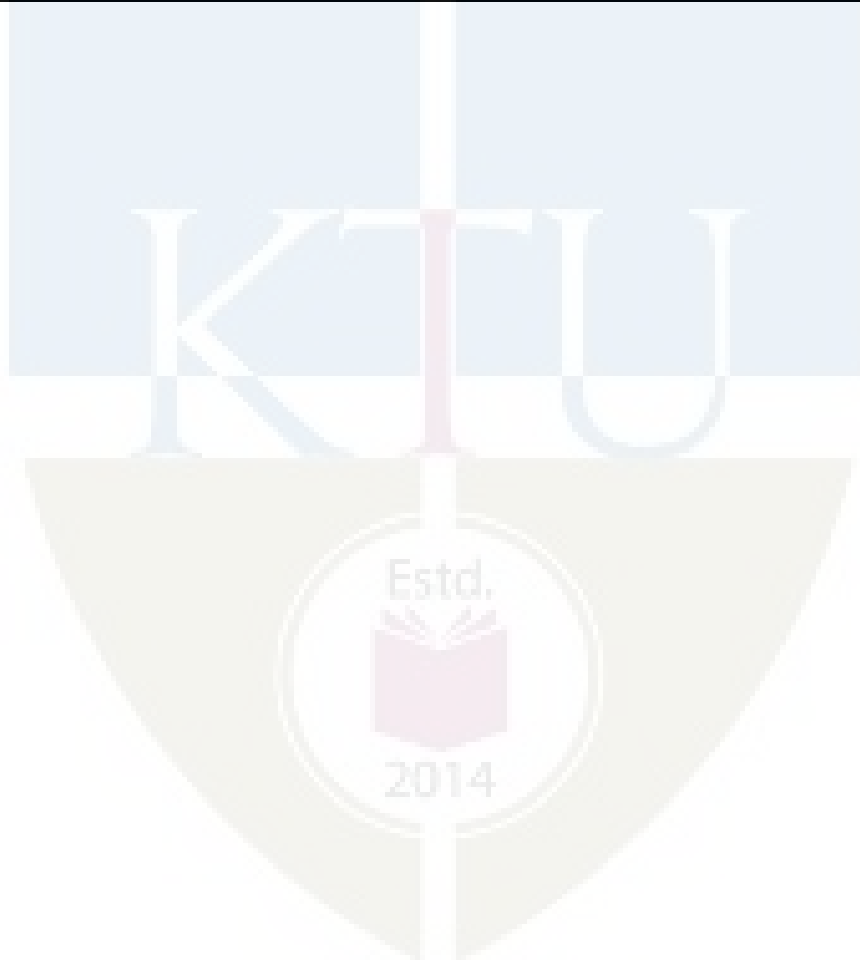
The Principals of the concerned Engineering Colleges with the help of the Chairmen/Chairperson will conduct the practical examination with the approval from the University and bonafide work / laboratory record, hall ticket, identity card issued by college are mandatory for appearing practical University examinations. No practical examination should be conducted without the presence of an external examiner appointed by the University.

References Books:

1. Daryl Logan, A First course in Finite Element Method, Thomson Learning, 2007
2. David V Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill, 2003
3. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill, 2007
4. Mikell P. Groover and Emory W. Zimmer, CAD/ CAM – Computer aided design and manufacturing, Pearson Education, 1987
5. T. R. Chandrupatla and A. D. Belagundu, Introduction to Finite Elements in Engineering, Pearson Education, 2012

Experiment List (Minimum 12 exercises)

SL.NO	PART - A (Minimum 6 models)	COURSE OUTCOMES	HOURS
1	Creation of high end part models (minimum 2 models, Questions for examinations must not be taken from this portions)	CO1, CO2	6
2	Creating assembly models of Socket and spigot joint, Knuckle Joint, Rigid flange couplings, Bushed Pin flexible coupling, Plummer block, Single plate clutch and Cone friction clutch. Pipe joints, Screw jack, Tail stock etc. (minimum 4 models)	CO1, CO2, CO3	12
PART – B (Minimum 6 problems)			
3	Structural analysis. (minimum 3 problems)	CO4, CO5	6
4	Thermal analysis. (minimum 2 problems)	CO4, CO5	3
5	Fluid flow analysis. (minimum 1 problem)	CO4, CO5	3



**END SEMSTER EXAMINATION
MODEL QUESTION PAPER
MEL332: COMPUTER AIDED DESIGN AND ANALYSIS LAB**

Duration : 2.5 hours

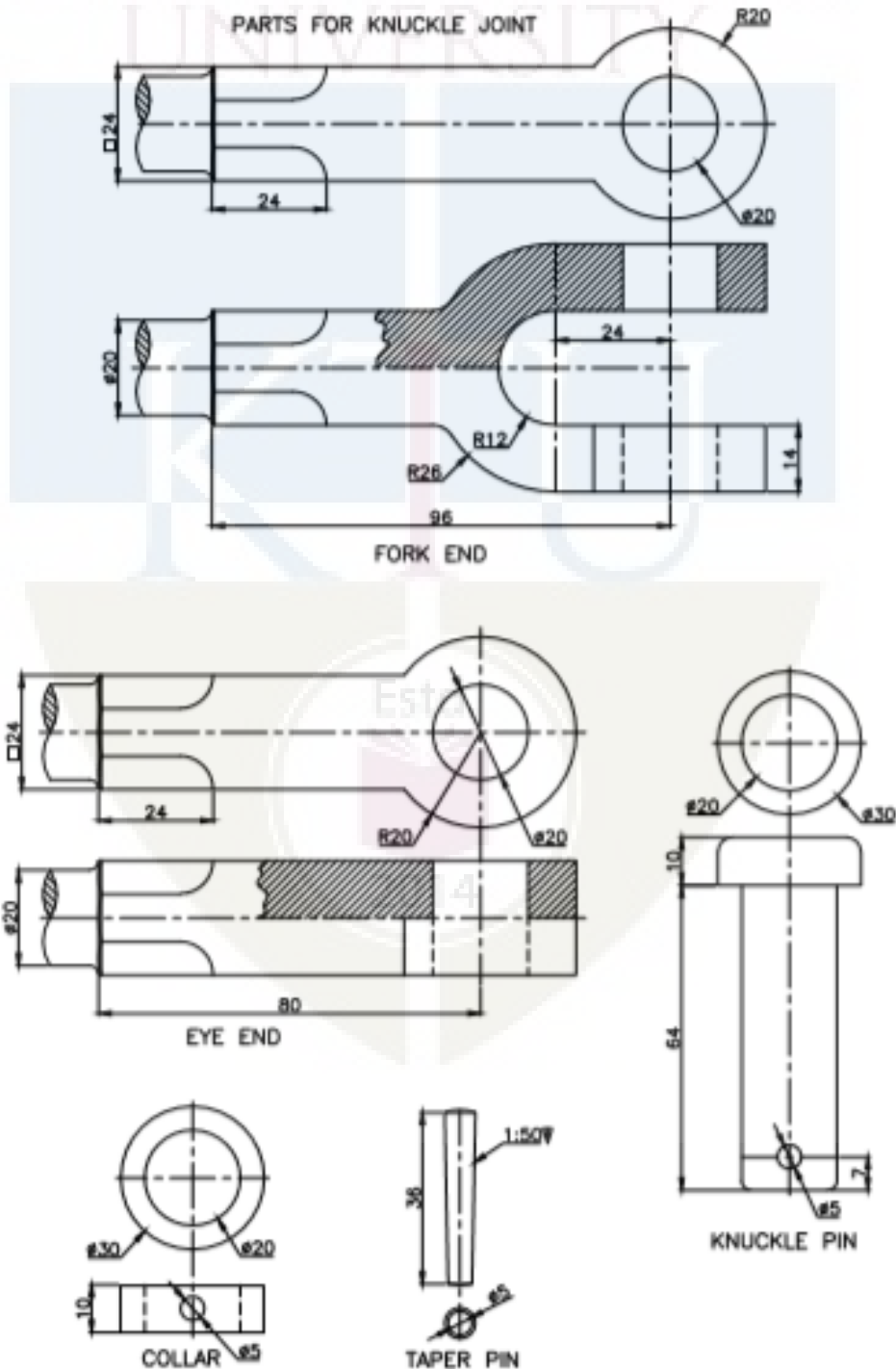
Marks : 75

Note :

1. All dimensions in mm
2. Assume missing dimensions appropriately
3. A4 size answer booklet shall be supplied
4. Viva Voce shall be conducted for 10 marks

PART A (ASSEMBLY MODELLING) – 35 marks

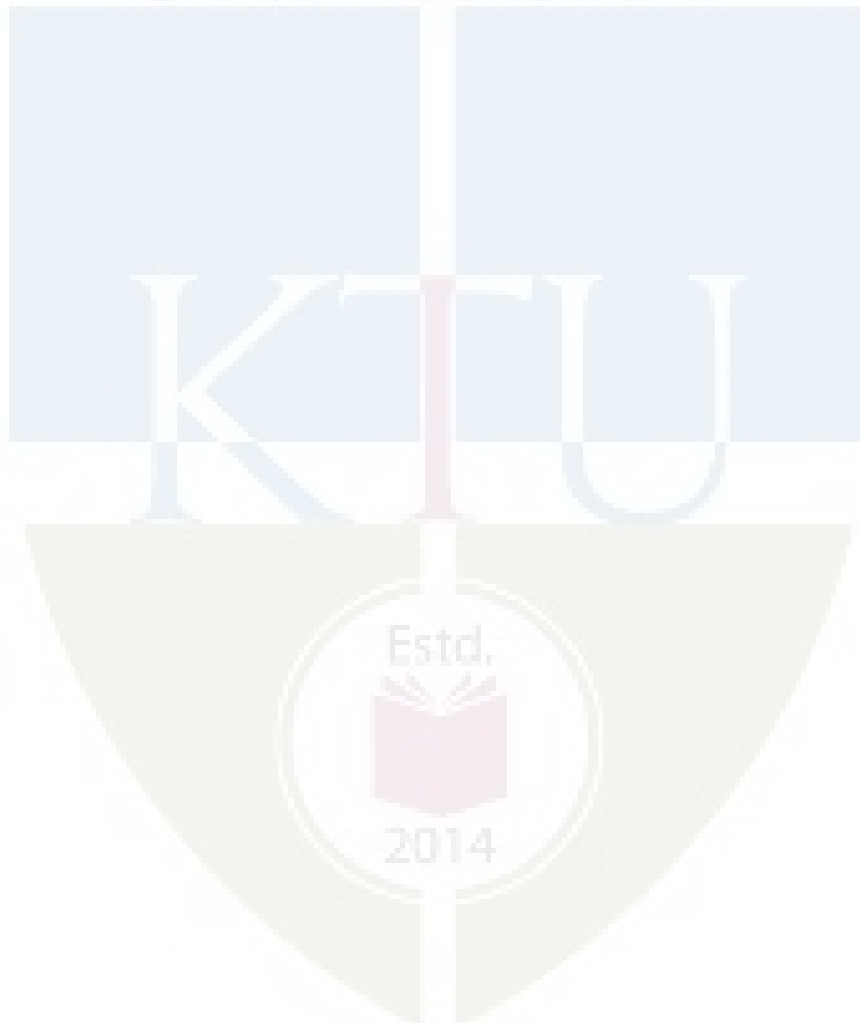
1. Create an assembly model using the part details given below



PART B (FINITE ELEMENT ANALYSIS) – 30 marks

2. Air flows over a long cylinder of 150mm diameter at a velocity of 3m/sec at a temperature of 105° F. Using this data and applying finite element technique find
 - a. Max velocity
 - b. Plot flow trajectories
 - c. Cut plot of velocity

APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY



CODE MUL332	ELECTRICAL SYSTEMS LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This lab is intended to impart training to auto mobile engineering students on the working of various types of electrical machines. It is also intended that students will be able to acquire some knowledge on the working of speed control of dc motors.

Prerequisite: Nil

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

CO 1	To understand the working of a single phase transformer
CO 2	To understand the working of dc generators
CO 3	To understand the load characteristics of dc series motor
CO 4	To understand the load characteristics of 3-phase squirrel cage induction motor
CO 5	To understand the load characteristics of 3-phase slip ring induction motor
CO 6	To understand operation of four quadrant chopper dc motor drive

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							2	2	2		2
CO 2	2							2	2	2		2
CO 3	2							2	2	2		2
CO 4	2							2	2	2		2
CO 5	2							2	2	2		2
CO 6	2	1			2			2	2	2		2

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: The following guidelines should be followed regarding award of marks

- | | |
|--|------------|
| (a) Preliminary work | : 15 Marks |
| (b) Implementing the work/Conducting the experiment | : 10 Marks |
| (c) Performance, result and inference (usage of equipments and trouble shooting) | : 25 Marks |
| (d) Viva voce | : 20 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.

Reference Books

1. Fitzgerald, A. E., Kingsley, C., Umans, S. D., & James, B. (2003). *Electric machinery* (Vol. 5, pp. 178-179). New York: McGraw-Hill.
2. Guru, B. S., & Hiziroglu, H. R. (2001). *Electric machinery and transformers* (Vol. 726). New York: Oxford university press.
3. DW, N., & Sen, P. K. (1999). *Electric drives*. PHI Learning Pvt. Ltd..

List of Exercises/Experiments:

(Lab experiments may be given considering 12 sessions of 3 hours each.)

1. Load test on single phase transformer
2. OC and SC test on single phase transformer
3. Open circuit characteristics of dc shunt generators.
4. Load test on dc shunt generator.
5. Load test on cumulatively compounded dc generator.
6. Load test on differentially compounded dc generator.
7. Load test on dc series motor.
8. Load test on three phase squirrel cage induction motor
9. Load test on three phase slip ring induction motor.
10. Starting of three phase induction motor using star-delta/autotransformer methods.
11. No-load and Blocked rotor tests on three phase squirrel cage induction motor
12. Study of four quadrant chopper dc drive.

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SEMESTER VI

PROGRAM ELECTIVE I



CODE MUT312	COURSE NAME VEHICLE MAINTENANCE	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims at providing the students, an insight on the various service and maintenance, trouble shoots and diagnostic tools used in automobiles.

Prerequisite: Nil

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

CO 1	Understand the need for vehicle maintenance and its importance
CO 2	Familiarize the maintenance procedure for various components of an automobile
CO 3	Identify various troubles and troubleshooting related to the automobile components.
CO 4	Familiar with Diagnostic tools used in Automobiles for detection of problems
CO 5	Rectify the problems occurring in various components an automobile

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	-	1	1	-	-	2	-	1
CO 2	2	1	-	2	-	1	2	-	-	2	-	1
CO 3	-	1	-	1	-	1	1	-	-	2	-	1
CO 4	-	-	-	-	-	1	1	-	-	2	-	1
CO 5	-	1	-	1	-	2	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
Analyze			
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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. State the importance of maintenance.
2. List the requirements of a service station.
3. Define about maintenance schedule for different types of automobiles.

Course Outcome 2 (CO2)

1. State the importance of engine overhauling
2. List the troubles and troubleshooting related to engines.
3. Define the use of different engine fault diagnosing instruments

Course Outcome 3(CO3):

1. Demonstrate the importance of fuel pump calibration and testing
2. List different methods for fault diagnosis in fuel injection system.
3. Describe about maintenance of cooling systems.

Course Outcome 4 (CO4):

1. Define in detail about servicing of transmission system.
2. Discuss in detail about servicing of braking system.
3. Describe the importance of wheel alignment in an automobile.

Course Outcome 5 (CO5):

1. Discuss about different methods for servicing of electrical accessories.
2. Describe in detail about maintenance of battery.

3. Demonstrate the importance of ignition system in engines.

Model Question paper

QP CODE: _____

PAGES:.....

Reg. No: _____
: _____

Name _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR
COURSE CODE: MUT 312
COURSE NAME: VEHICLE MAINTENANCE

Max. Marks: 100

Duration: 3 Hours

PART A

- I. Answer all questions. Each question carries 3 marks
1. Why a regular service is important for a vehicle?
 2. Explain the Importance of Job Card with the help of a sample job card.
 3. List the causes for “engine cranks slowly, but does not start”
 4. List down the corrective actions if the engine lacks power, acceleration or high-speed performance
 5. Explain the importance of Wheel alignment in a car
 6. List the reasons for clutch slipping while engaging
 7. Differentiate between OBD I and OBD II scanners used for electronic fault diagnosis
 8. Discuss any one method for testing of an automobile battery
 9. List down the procedure for setting the idle speed of a carburettor engine
 10. Why do we require to add anticorrosion and antifreeze additives in cooling system of a vehicle?

(10 x 3 =30 marks)

PART B

- II. Answer all questions. Each question carries 14 marks
- 11 (a) What are the different types of maintenances carried out for a vehicle? Explain each
OR
 - 12 (a) With the help of a chart explain about PDI.
 - 13 (a) What are the steps involved in dismantling of an engine? List the precautions to be observed while dismantling
OR
 - 14 (a) Discuss about the use of OBD for trouble shooting in automobiles.
 - 15 (a) List any five major complaints in a fuel injection system and prepare a chart showing the possible causes and corrective actions.

OR

- 16 (a) Discuss in detail about the maintenance of cooling system.
- 17 (a) Discuss about common complaints observed in the steering and suspension system of a vehicle. List down its causes and remedial measures

OR

- 18 (a) List the complaints in the power brake system. List its possible causes and remedies

- 19 (a) Explain in detail about the servicing of charging system used in automobiles

OR

- 20(a) Discuss about various starting system troubles observed in a vehicle. Explain the method for trouble shooting of these complaints.

(5 x 14=60 marks)

Syllabus

Module 1

Maintenance, Records and Schedules: Importance of maintenance, types of maintenance, Inspection, scheduled maintenance, Job card, PDI chart, requirement of service station, service station records (stores & maintenance), layout and personnel for service station, Typical maintenance schedule for two-wheeler, LMV and HMV.

Module 2

Engine trouble diagnosis and tune-up: Overhauling of engine - types of overhauling (Top overhauling and major overhauling), specific tools used for overhauling, de-carbonizing and degreasing, engine time up, Engine fault diagnosing instruments, use of automobile stethoscope, computerized engine analyzers/scanners, OBD II usage for troubleshooting, troubles and troubleshooting related to engines.

Module 3

Maintenance and repair of fuel supply, Lubrication and cooling system: Fuel pump testing, Carburetor servicing and tuning, servicing of gasoline injection system, FIP calibration and

phase setting, injector testing, Electronic fuel injection and engine management. service - fault diagnosis- servicing emission controls.

Lubrication maintenance, lubricating oil changing, greasing of parts, engine oil change intervals. Maintenance of Cooling systems, water pump and radiator, thermostat, anti-corrosion and antifreeze additives.

Module 4

Maintenance and Repair of chassis components: Servicing of clutch assembly, gear box, propeller shaft, troubles and troubleshooting chart on transmission, differential maintenance and repair, backlash adjustment, servicing of braking system, identification and rectification of brake faults, brake testing, steering system maintenance and repair, tyre rotation, tyre re-treading, checking and adjusting of suspension system, wheel balancing, wheel alignment.

Module 5

Maintenance of Auxiliaries: Maintenance of starter motor, dynamo and alternator, regulator unit, battery maintenance, methods of testing & servicing various electrical accessories like horn, headlight (aiming and focusing), gauges, Testing the spark plug and ignition coil with special equipment, checking and setting the ignition timing in conventional engines.

Text Book:

1. Ed May, "Automotive Mechanics Volume 1 & 2", Mc Graw Hill Publications, 2003
2. Boyce Dwiggin, Automobile Repair guide, Theodor Audel and Co., Indiana, 1978.
3. A-W Judge- Maintenance of High-speed Diesel Engine, Chapman Hall Ltd

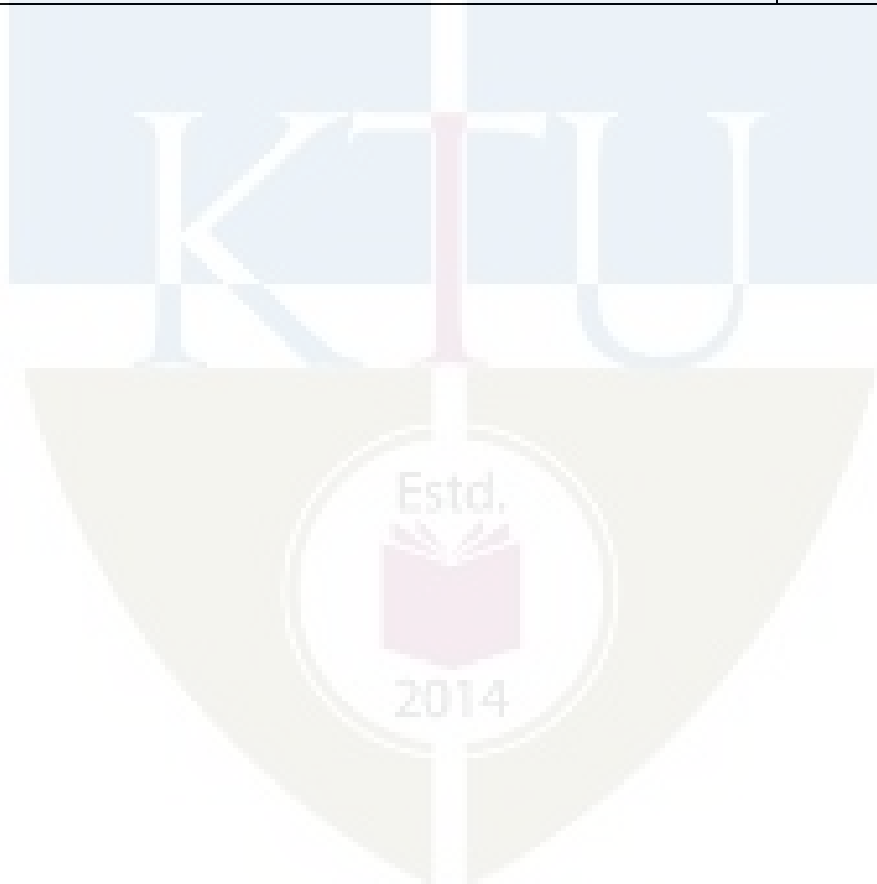
References:

1. G.B.S. Narang - Automobile Engineering, Khanna Publishers
2. Knott and Phil Knott, "An Introductory Guide to Motor Vehicle Maintenance: Light Vehicles", EMS publishing, 2010
3. Antony.E. Schwaller - Motor Automotive Technology, Delmar Publishers
4. A.W Judge - Motor Vehicle Engine Servicing, 3rd Edition, Pitman paper mark, London
5. Bosch Automotive Handbook, Sixth Edition, 2004
6. Vehicle Service Manuals and reputed manufacturers.
7. Tim Giles, "Automotive service: Inspection, maintenance and repair", 3rd edition, 2007

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Maintenance, Records and Schedules	
1.1	Importance of maintenance, types of maintenance	1
1.2	Inspection, scheduled maintenance	1
1.3	Job card, PDI chart, requirement of service station	1
1.4	service station records (stores & maintenance)	1
1.5	layout and personnel for service station	1
1.6	Typical maintenance schedule for two-wheeler	1
1.7	Typical maintenance schedule for LMV, HMTV	1
2	Maintenance of Engine	
2.1	Engine trouble diagnosis and tune-up: Overhauling of engine - types of overhauling (Top overhauling and major overhauling)	1
2.2	Specific tools used for overhauling, de-carbonizing and degreasing	1
2.3	Engine tuning	1
2.4	Engine fault diagnosing instruments, Use of automobile stethoscope	1
2.5	Computerized engine analyzers/scanners	1
2.6	OBD II usage for troubleshooting	1
2.7	Troubles and troubleshooting related to engines	1
3	Maintenance and repair of fuel supply, Lubrication and cooling system	
3.1	Fuel pump testing, Carburetor servicing and tuning	1
3.2	Servicing of gasoline injection system, FIP calibration and phase setting, injector testing	1
3.3	Electronic fuel injection and engine management	1
3.4	Service - fault diagnosis- servicing emission controls.	1
3.5	Lubrication maintenance, lubricating oil changing, greasing of parts, engine oil change intervals.	1
3.6	Maintenance of Cooling systems, water pump and radiator, thermostat.	1
3.7	Anti-corrosion and antifreeze additives	1
4	Maintenance and Repair of chassis components	
4.1	Servicing of clutch assembly, gear box, propeller shaft	1
4.2	Troubles and troubleshooting on transmission	1
4.3	Differential maintenance and repair, backlash adjustment	1
4.4	Servicing of braking system	1
4.5	Identification and rectification of brake faults, brake testing	1

4.6	steering system maintenance and repair, Tyre rotation, tyre re-treading	1
4.7	Checking and adjusting of suspension system, wheel balancing, wheel alignment	1
5	Maintenance of Auxiliaries	
5.1	Maintenance of starter motor	1
5.2	Maintenance of dynamo and alternator, regulator unit	1
5.3	Battery maintenance	1
5.4	Methods of testing & servicing various electrical accessories like horn, headlight (aiming and focusing)	1
5.5	Methods of testing & servicing various electrical accessories like gauges	1
5.6	Testing the spark plug, Testing of Ignition coil with special equipment	1
5.7	Checking and setting the ignition timing in conventional engines	1



CODE MET 312	COURSE NAME NON-DESTRUCTIVE TESTING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:

Nondestructive Testing (NDT) plays an extremely important role in quality control, flaw detection and structural health monitoring covering a wide range of industries. There are varieties of NDT techniques in use. This course will first cover the fundamental science behind the commonly used NDT methods to build the basic understanding on the underlying principles. It will then go on to cover the process details of each of these NDT methods.

Prerequisite: NIL

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

CO 1	Have a basic knowledge of surface NDT which enables to carry out various inspections in accordance with the established procedures.
CO 2	The students will be able to differentiate various defect types and select the appropriate NDT methods for the specimen.
CO 3	Calibrate the instrument and evaluate the component for imperfections.
CO 4	Have a basic knowledge of ultrasonic testing which enables them to perform inspection of samples.
CO 5	Have a complete theoretical and practical understanding of the radiographic testing, interpretation and evaluation.

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	2									1
CO 2	3	3	2									1
CO 3	3	3	1									2
CO 4	3	3	2									2
CO 5	3	3	1									1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	25	25	25
Understand	25	25	25

Apply	30	30	30
Analyse	10	10	10
Evaluate	10	10	10
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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain why NDT methods were initially developed
2. Describe the uses of NDT
3. Define the functionality of Destructive method

Course Outcome 2 (CO2)

1. Name the various nondestructive test methods
2. Recognize the NDT method abbreviations
3. Briefly explain each NDT method

Course Outcome 3(CO3):

1. Explain the discontinuities inherent in various manufacturing processes
2. Define the causes, prevention, and repair of those welding discontinuities

3. Explain the discontinuities inherent in various welding processes

Course Outcome 4 (CO4):

1. Explain basic principle of Radiographic examination.
2. Discuss principle of radiographic testing and give its application and limitation
3. Explain the principle, application and disadvantages of Radiographic Testing.

Course Outcome 5 (CO5):

1. Describe the various types of RT equipment
2. Describe the basic principles of gamma and X-ray generation
3. Name the three means of protection to help reduce exposure to radiation

MODEL QUESTION PAPER

SIXTH SEMESTER MECHANICAL ENGINEERING

NON DESTRUCTIVE TESTING - MET 312

**Max. Marks : 100
Hours**

Duration : 3

Part – A

Answer all questions, each question carries 3 marks

1. Define Non-destructive testing?
2. Explain the basic principle of Visual testing?
3. Explain the sequence of operation of Liquid penetrant testing?
4. Explain the basic principle of Liquid penetrant testing?
5. How are the materials classified based on their interaction with a magnetic field?
6. Explain the Hysteresis Loop and Magnetic Properties of a material?
7. Compare X-rays and Gamma rays?
8. What is Snell's Law and its significance in Ultrasonic Testing?
9. Define the terms (a) Radiation Energy, (b) Intensity
10. What are the physical aspects of E.C.T?

PART -B

Answer one full question from each module.

MODULE – 1

11. a) With the help of suitable examples, differentiate between destructive and nondestructive testing techniques. **(8 Mark)**
b) With the help of a neat diagram, explain computer enhanced visual inspection system. **(6 Mark)**

OR

12. a) Explain visual inspection process. Also explain about the different types of optical aids used in the process. **(8 Mark)**
b) List the applications and Limitations of Visual inspection technique in ND **(6Mark)**

MODULE – 2

13. a) How are the penetrants classified based on **(8 Mark)**
a. Physical properties
b. Removal techniques
c. Strength of indication
b) What are the methods used to remove excess penetrants during LPI **(6 Mark)**

OR

14. a) Explain the working principle of liquid penetrant inspection (LPI). With neat sketches explain the various steps involved in performing LPI. **(8 Mark)**
b) Explain different types of developers and how it is being applied **(6 Mark)**

MODULE – 3

15. a) With the help of neat sketches explain about any four types of magnetization techniques used in magnetic particle inspection (MPI). **(8 Mark)**
b) What are the differences between dry and wet continuous MPI? **(6 Mark)**

OR

16. a) Differentiate between direct and indirect method of magnetization. Write the advantages and disadvantages of both methods. **(8 Mark)**
b) What is continuous testing and residual technique of MPI **(6 Mark)**

MODULE – 4

17. a) With the help of neat figures, differentiate between through transmission technique and pulse echo testing techniques used in ultrasonic testing. **(8 mark)**
b) What are the different types of probes used in ultrasonic testing? **(6 mark)**

OR

18. a) What are the different wave forms used in ultrasonic testing? **(8 Mark)**
b) With neat sketches explain the following: **(6 mark)**
i) A-Scan ii) B-Scan iii) C-Scan

MODULE – 5

19. a) With neat sketches explain about the different inspection techniques in radiography testing (RT). **(8 Mark)**
 b) Explain about various steps involved in film processing in RT. **(6 mark)**

OR

20. a) Explain the following terms associated with ECT: **(8 Mark)**
 i) Lift off effect ii) Edge effect iii) End effect
 b) Explain about eddy current testing (ECT) technique in detail. **(6 mark)**

SYLLABUS

Module 1

NDT Versus Mechanical testing-Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation-Relative merits and limitations-various physical characteristics of materials and their applications in NDT.

Visual Inspection: Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, Boroscopes and fibro scopes– light sources and special lighting–calibration- computer enhanced system

Module 2

Liquid Penetrant Inspection: Principles – types and properties of liquid penetrants – developers – advantages and limitations of various methods - Preparation of test materials – Application of penetrants to parts, removal of excess penetrants, post cleaning – Control and measurement of penetrant process variables –selection of penetrant method – solvent removable, water washable, post emulsifiable – Units and lighting for penetrant testing – calibration- Interpretation and evaluation of test results - dye penetrant process applicable codes and standards.

Module 3

Magnetic Particle Inspection (MPI): Important terminologies related to magnetic properties of material, principle-magnetizing technique, procedure, and equipment, fluorescent magnetic particle testing method, sensitivity-application and limitation-Methods of magnetization, magnetization techniques such as head shot technique, cold shot technique- central conductor testing, and magnetization using products using yokes-direct and indirect method of magnetization - continuous testing of MPI, residual technique of MPI- checking devices in MPI, Interpretation of MPI, indications, advantage and limitation of MPI.

Module 4

Ultrasonic Testing: Basic principles of sound propagation, types of sound waves, Principle of UT-methods of UT, their advantages and limitations-Piezoelectric Material, Various types of transducers/probe-Calibration methods, contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, ultrasonic testing techniques resonance testing, through transmission technique, pulse echo testing technique, instruments

used UT, accessories such as transducers, types, frequencies, and sizes commonly used. Reference of standard blocks-technique for normal beam inspection-flaw characterization technique, defects in welded products by UT-Thickness determination by ultrasonic method;- Study of A, B and C scan presentations-Time of Flight Diffraction (TOFD).

Module 5

Radiography: X-rays and Gamma rays, Properties of X-rays relevant to NDE - Absorption of rays - scattering. Characteristics of films- graininess, Density, Speed, Contrast. Characteristic curves. Inspection techniques like SWSI, DWSI, DWDI, panoramic exposure, real time radiography, films used in industrial radiography

Eddy Current Testing: Generation of eddy currents – effect of change of impedance on instrumentation – properties of eddy currents – eddy current sensing elements, probes, type of coil arrangement – absolute, differential, lift off, operation, applications, advantages, limitations Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration of ECT, relation between frequency and depth of penetration in ECT.

Text Books

1. Baldev Raj, Practical Non – Destructive Testing, Narosa Publishing House, 1997
2. J.Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011).
3. B.Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3 rd edition (2007).
4. T. Rangachari, J. Prasad and B.N.S. Murthy, Treatise on Non-destructive Testing and Evaluation, Navbharath Enterprises, Vol.3, (1983).
5. Ed. Peter.J. Shull, Non-destructive Evaluation: Theory, Techniques, and Applications, Marcel Dekker (2002). 2.

Reference Books

1. C. Hellier, Handbook of Non-Destructive Evaluation, McGraw-Hill Professional, 1st edition (2001).
2. J. Thomas Schmidt, K. Skeie and P. MacIntire, ASNT Non Destructive Testing Handbook: Magnetic Particle Testing, American Society for Non-destructive Testing, American Society for Metals, 2nd edition (1989).
3. Krautkramer, Josef and Hebert Krautkramer, Ultrasonic Testing of Materials, Springer Verlag, 1990

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
MODULE 1		
1.1	NDT Versus Mechanical testing-Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation	2
1.2	Relative merits and limitations-various physical characteristics of materials and their applications in NDT	1
1.3	Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods	1
1.4	Mirrors, magnifiers, Boroscopes and fibro scopes	1
1.5	light sources and special lighting, calibration- computer enhanced system	2
MODULE 2		
2.1	Liquid Penetrant Inspection: Principles – types and properties of liquid penetrants – developers	1
2.2	Advantages and limitations of various methods - Preparation of test materials	1
2.3	Application of penetrants to parts, removal of excess penetrants, post cleaning	1
2.4	Control and measurement of penetrant process variables –selection of penetrant method	1
2.5	solvent removable, water washable, post emulsifiable – Units and lighting for penetrant testing	1
2.6	calibration- Interpretation and evaluation of test results - dye penetrant process applicable codes and standards	2
MODULE 3		
3.1	Magnetic Particle Inspection (MPI): Important terminologies related to magnetic properties of material	1
3.2	Principle-magnetizing technique, procedure, and equipment, fluorescent magnetic particle testing method, Sensitivity	1
3.3	Methods of magnetization, magnetization techniques such as head shot technique, cold shot technique- central conductor testing,	1
3.4	magnetization using products using yokes-direct and indirect method of magnetization - continuous testing of MPI	1
3.5	residual technique of MPI- checking devices in MPI	1
3.6	Indications, advantage and limitation of MPI.	1
MODULE 4		
4.1	Ultrasonic Testing: Basic principles of sound propagation, types of	

	sound waves, Principle of UT-methods of UT	1
4.2	Piezoelectric Material, Various types of transducers/probe Calibration methods, contact testing and immersion testing, normal beam and straight beam testing,	1
4.3	Angle beam testing, dual crystal probe, ultrasonic testing techniques resonance testing, through transmission technique, pulse echo testing technique	1
4.4	Accessories such as transducers, types, frequencies, and sizes commonly used. Reference of standard blocks	1
4.5	Technique for normal beam inspection Thickness determination by ultrasonic method	1
4.6	Study of A, B and C scan presentations, Instruments used UT	1
4.7	Time of Flight Diffraction (TOFD).	1
MODULE 5		
5.1	Radiography: X-rays and Gamma rays, Properties of X-rays relevant to NDE - Absorption of rays - scattering	1
5.2	Characteristics of films- graininess, Density, Speed, Contrast. Characteristic curves. Inspection techniques like SWSI, DWSI, DWDI	1
5.3	Panoramic exposure, real time radiography, films used in industrial radiography	1
5.4	Eddy Current Testing: Generation of eddy currents – effect of change of impedance on instrumentation – properties of eddy currents	1
5.5	Eddy current sensing elements, probes, type of coil arrangement – absolute, differential, lift off, operation, applications, advantages, limitations	1
5.6	Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration of ECT	1
5.7	Relation between frequency and depth of penetration in ECT.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MUT322	VEHICLE BODY ENGINEERING	PEC	2	1	0	3

Preamble: At the end of the course, the students will be able to have a sound knowledge for the design of the vehicles body to give maximum comfort for the passengers and exposed to the methods of stream lining the vehicles body to minimize drag.

Prerequisite: Nil

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

CO 1	Understand the need for vehicle ergonomics and its importance
CO 2	Familiarize the various styling forms of car body
CO 3	Understand various commercial vehicle body styles and its dimensions
CO 4	Understand the various aspects of vehicle aerodynamics
CO 5	Illustrate comfort and safety considerations that have to be taken into account while designing a vehicle

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	-	3	2	-	-	-	-	-	-	-	2
CO 2	-	1	3	-	-	-	-	-	-	-	-	-
CO 3	2	-	3	-	-	-	-	-	-	-	-	2
CO 4	3	2	3	-	3	-	2	-	-	-	-	-
CO 5	1	1	2	2	2	1	-	-	-	-	1	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
Analyze			
Evaluate			

Create			
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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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. State the importance of cabin ergonomics.
2. Explain the concepts of suspension seats
3. Describe and sketch the structure of split frame seating

Course Outcome 2 (CO2)

1. Illustrate and explain various car body styling forms
2. Explain the considerations for better visibility
3. Explain the methods to improve visibility

Course Outcome 3(CO3):

1. Illustrate and explain double skin body construction
2. Explain various commercial vehicle body styling
3. Explain the structure of fifth wheel

Course Outcome 4 (CO4):

1. Define in detail about vehicle aerodynamics and its factors
2. Discuss in detail about Aerodynamic drag and its types
3. Describe the methods used to reduce drag

Course Outcome 5 (CO5):

1. Explain the purpose of crash tests and criteria considered for crash test
2. Describe in detail about vehicle vibrations
3. Demonstrate the importance of secondary safety systems in vehicles

Model Question paper

QP CODE:

PAGES:

Reg. No: _____ **Name :** _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MUT322

Course Name: VEHICLE BODY ENGINEERING

Max. Marks: 100

Duration: 3 Hours

Part A

Answer all questions, each question carries 3 marks

1. Explain the term ergonomics
2. Describe split frame seating
3. What is meant by blind spot in automobiles?
4. Illustrate and explain a 4 door saloon car
5. Explain double skin body construction
6. Briefly explain body styling of forward control pick up
7. Define in detail about vehicle aerodynamics and its factors
8. List and explain any 3 methods to reduce drag
9. What is the purpose of using silicon rubber in body construction?
10. What is meant by Secondary Restraint System? (10*3=30 marks)

Part B

Answer any five questions, each one carries 14 marks

11. Explain with the help of neat sketch about commercial vehicle cabin ergonomics

OR

12. List and explain various dashboard instruments used in automobiles

13. Explain any 5 types of car body styling forms

OR

14. Describe various factors affecting visibility and methods to improve visibility

OR

15. Illustrate and explain articulated bus body construction

OR

16. Explain in detail about double Decker buses

17. Describe and illustrate wind tunnel testing

OR

18. List and explain various flow visualization techniques used in automobile body design

19. Explain various automotive safety systems used and its classifications

OR

20. Define and categorize various sources of vibration and methods to suppress the same.

(5*14=70 marks)

Syllabus

Module 1

ERGONOMICS: Introduction, seating dimensions, interior ergonomics, ergonomics system design, seat comfort, suspension seats, split frame seating, back pain reducers, dash board instruments, electronic displays, commercial vehicle cabin ergonomics, mechanical package layout, goods vehicle layout.

Module 2

CAR BODY DETAILS: Types: saloon, convertibles, limousine, estate car, racing and sports car. Visibility - Regulations, driver's visibility, tests for visibility, methods of improving visibility and space in cars. Car body construction - Design criteria and initial tests.

Module 3

TRUCK AND SPECIALITY PASSENGER VEHICLES: Commercial vehicle body technology, trends, special goods vehicle, special haulage vehicles cab body. Buses and coaches, bus body layout, floor height, engine location, entrance and exit locations, seating dimensions, constructional details, frame construction, double skin construction, types of metal sections used, regulations, conventional and integral type construction.

PSV (Passenger Specialty Vehicle) structural design, low floor and articulated buses, three wheelers and light weight trailers.

Module 4

VEHICLE AERODYNAMICS- Objectives, Vehicle drag and types. Various type of forces and moments. Effect of forces and moments. Side wind effects on forces and moments. Various body optimization techniques for minimum drag. Wind tunnels, Principle of operation, Types. Wind tunnel testing such as: Flow visualization techniques, Airflow management test, measurement of various forces and moments by using wind tunnel.

Module 5

DESIGN, SAFETY AND FATIGUE ASPECTS: Design for press working, design for spot welding, adhesives and sealants, goods vehicle structure design, chassis frame configuration, structural properties of chassis frame members. Crash tests, forces in roll over, head on impact, plastic collapse and analysis, fatigue and vibration, structural vibration.

(8)

TEXT BOOKS:

1. John Fenton, "Handbook of Automotive Body and Systems Design", John Wiley & Sons, 2013
2. John Fenton, "Handbook of Automotive Construction and Design Analysis", John Wiley & Sons, 2014
3. Powloski, J., "Vehicle Body Engineering", Business Books Ltd., 1998.

REFERENCES:

1. Braithwaite.J.B., Vehicle Body building and drawing, Heinemann Educational Books Ltd., London.
2. Heinz Heisler, Advanced Vehicle Technology, 2nd edition, Butterworth –Heinemann, 2002.
3. Wolf-Heinrich Hucho, —Aerodynamics of road vehicles, 4th edition, 2000.
4. Julian Happian Smith, "Introduction to Modern Vehicle Design", Butterworth Publisher, 2001.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	Module 1 (8 hours)	
1.1	Introduction, seating dimensions, interior ergonomics, ergonomics system design	2
1.2	Seat comfort, suspension seats, split frame seating, back pain reducers	2
1.3	Dash board instruments, electronic displays	1
1.4	Commercial vehicle cabin ergonomics	1
1.5	Mechanical package layout, goods vehicle layout.	1
2	Module 2 (7 hours)	
2.1	Car body types: saloon, convertibles, limousine, estate car, racing and sports car	2
2.2	Regulations for visibility, driver's visibility	1
2.3	Tests for visibility, methods of improving visibility and space in cars.	2
2.4	Car body construction - Design criteria and initial tests.	2

3	Module 3 (9 hours)	
3.1	Commercial vehicle body technology	1
3.2	trends, special goods vehicle, special haulage vehicles cab body	1
3.3	Buses and coaches, bus body layout, floor height, engine location, entrance and exit locations, seating dimensions, constructional details, frame construction, double skin construction	2
3.4	Types of metal sections used, regulations, conventional and integral type construction.	1
3.5	PSV (Passenger Specialty Vehicle) structural design, low floor and articulated buses, three wheelers and light weight trailers.	2
4	Module 4 (8 hours)	
4.1	Objectives, Vehicle drag and types. Various type of forces and moments. Effect of forces and moments	2
4.2	Side wind effects on forces and moments. Various body optimization techniques for minimum drag	1
4.3	Wind tunnels, Principle of operation, Types. Wind tunnel testing such as: Flow visualization techniques	2
4.4	Airflow management test, measurement of various forces and moments by using wind tunnel.	2
5	Module 5 (8 hours)	
5.1	Design for press working, design for spot welding, adhesives and sealants	2
5.2	Goods vehicle structure design, chassis frame configuration, structural properties of chassis frame members	2
5.3	Crash tests, forces in roll over, head on impact, plastic collapse and analysis	2
5.4	Fatigue and vibration, structural vibration.	1

Estd.



2014

CODE MUT332	HEATING VENTILATION AND AIR CONDITIONING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:

This course is designed to equip the students with the fundamentals of HVAC systems used in automobiles, their operation and maintenance practices.

Prerequisite: UG course on Thermodynamics.

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

CO 1	Designation of refrigerants and their selection for common applications.
CO 2	Determine performance of vapour compression refrigeration systems
CO 3	Understand basic principles of wet and dry sorption cooling/heating systems
CO 4	Design supply condition of air for different air conditioning processes.
CO 5	Understand components of auto air conditioning systems, their testing and maintenance.

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	2					2					
CO 2	3	2			2				2			
CO 3	3	2					2					
CO 4	3	2										
CO 5	3	2										

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	30
Apply	20	20	60
Analyse			
Evaluate			

Create			
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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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

- Designate the following refrigerants
 - CH₄
 - CCl₂H₂
 - NH₃
- Write the name of the chemical compound for the following refrigerants
 - R-50
 - R-12
 - R-717
- Select suitable refrigerants for the following applications and justify the answer
 - Ice plants
 - Computer centre
 - Super market

Course Outcome 2 (CO2)

- A R-12 vapour compression refrigeration system has a condensing temperature of 40°C. The refrigeration capacity is 7 TR. The liquid leaving the condenser is saturated liquid and compression is isentropic. Determine i. Refrigerant flow rate ii. Power required to run the compressor iii. COP of the system
- Discuss the effect of evaporator temperature and condenser temperature on performance of vapour compression refrigeration system with p-h plot.
- Discuss the effect of sub cooling and suction vapour superheat on the performance of vapour compression refrigeration system with suitable plots.

Course Outcome 3(CO3):

1. Discuss the characteristics of ideal binary mixture.
2. Explain the working principle of vapour absorption refrigeration system with PTX plot.
3. In a vapour absorption refrigeration system generator temperature is 210°C, evaporator temperature is 10°C and the condenser temperature is 35°C. Determine the COP of the system.

Course Outcome 4 (CO4):

1. Prove that $\phi = \frac{\mu}{1-(1-\mu)(p_s/p)}$ where ϕ is relative humidity and μ is degree of saturation
2. For the room air at 28°C DBT and 20°C WBT, Calculate a) Dew point temperature b) Relative humidity c) Specific humidity d) Degree of saturation e) Enthalpy of air (Use relevant correlations only. Psychrometric chart should not be used for solution)
3. An office building needs to be air conditioned.

The ambient air conditions are 35°C DB, 25°C WB and the indoor design conditions are 24°C DB, 50% RH.

RSH – 60 000 W & RLH – 15 000 W

Ventilation – 1000 L/s OA. Assume suitable BPF.

Find:

1. Outdoor air load (OATH)
 2. Grand total heat (GTH)
 3. Effective sensible heat factor (ESHF)
 4. Apparatus dewpoint temperature (t_{ADP})
 5. Dehumidified air quantity
 6. Entering and leaving conditions at the plant (t_{EDB} , t_{EWB} , t_{LDB} , t_{LWB})
- Represent the process and states in psychrometric chart.

Course Outcome 5 (CO5):

1. Discuss the case and duct system for air distribution.
2. How is a system charged with refrigerant?
3. How auto AC malfunctions are diagnosed using gauge reading?

Model Question Paper

Reg. No: _____

Name: _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: MUT332

Course Name: HEATING VENTILATION AND AIR CONDITIONING

Max. Marks:100**Duration: 3 hrs****Part A**

(Answer all questions. Each question carries 3 marks)

1. What do you mean by GWP and ODP of refrigerants?
2. Designate the following refrigerants:
 - a. NH_3 b. CCl_2F_2 c. CF_3Br
3. Represent vapour compression refrigeration cycle in T-s and p-h plots.
(Assume dry compression with no suction vapour superheat and no subcooling of liquid refrigerant in condenser.)
4. Define Tons of Refrigeration (TR). 5000 kg of water at 0°C is converted to ice at the same temperature in 12 hrs. Calculate the refrigeration capacity in TR.
5. What is Raoult's Law? What do you mean by positive and negative deviation from Raoult's Law?
6. In a vapour absorption refrigeration system generator temperature is 210°C , evaporator temperature is 10°C and the condenser temperature is 35°C . Determine the max COP of the system.
7. Represent the following processes on a psychrometric chart.
 - a. Cooling and dehumidification
 - b. Adiabatic saturation
8. Define the following
 - a) Relative Humidity b) Specific Humidity c) Degree of saturation
9. List some auto AC malfunctions are diagnosed using gauge reading.
10. What are the effects of moisture ingress in refrigerant circuit?

PART-B

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

Module-1

11. a) Discuss the milestones in the history of automobile air conditioning.
b) Discuss the working principle of evaporative coolers.
12. a) Discuss important thermodynamic requirements of refrigerants.
b) Explain eco friendly refrigerants.

Module-2

13. An ammonia vapour compression refrigeration system has a condensing temperature of 40°C . The refrigeration capacity is 20 TR. The liquid leaving the condenser is saturated liquid and compression is isentropic. Determine i. Refrigerant flow rate ii. Power required to run the compressor iii. COP of the system
14. Sketch a neat schematic of multi-compression refrigeration system with flash gas removal and flash intercooling Also depict this using the corresponding T-s and P-h plots.

Module-3

15. a) What are the advantages of vapour absorption refrigeration system over vapour compression refrigeration system? Discuss the working principle.
- b) Discuss the characteristics of ideal binary mixture. How actual mixture deviates from ideal behaviour?
16. Discuss the working principle of a solid sorption system with a neat schematic and p-T-X diagram

Module-4

17. For the room air at 30°C DBT and 22°C WBT, Calculate a) Dew point temperature b) Relative humidity c) Specific humidity d) Degree of saturation e) Enthalpy of air (Use relevant correlations only. Psychrometric chart should not be used for solution)
18. Air at 35°C DBT and 75% relative humidity enters a cooling coil at the rate of 200 m^3/min . The coil dew point temperature is 15°C and the bypass factor of the coil is 0.1. Determine the following:
- a) Temperature of air leaving the cooling coil.
- b) Capacity of cooling coil in TR
- c) Amount of water vapour removed per minute
- d) Sensible Heat Factor for the process.

Module-5

19. Discuss the case and duct system for air distribution in automobiles with a neat schematic.
20. Prepare a writeup on sensors and actuators used for climate control of passenger compartment in automobiles.

Syllabus

Module 1

Introduction to auto HVAC systems

History of auto air conditioning, Overview of technologies, development of refrigerants and compressors. Applications. Refrigerants: Primary and secondary refrigerants, Nomenclature of refrigerants, Thermo-physical properties and Selection of refrigerants, Mixed refrigerants.

(7 hours)

Module 2

Vapour Compression Refrigeration System (VCRS)

Units of refrigeration, COP, EER and SEER, Carnot refrigeration cycle, Standard vapour compression refrigeration system, Effect of condenser and evaporator temperature on performance, Effect of sub cooling and superheating, Actual VCRS system, Multistage VCRS, Flash gas removal and flash intercooling, Multi evaporator and cascade systems.

(8 hours)

Module 3

Vapour Absorption Refrigeration System (VARs)

Relevance of VARs, Basic principle of operation of VARs, Max. COP, Refrigerant absorbent mixtures and their properties, Raoult's law, Ideal and real mixtures, Ammonia-water VARs. PTX and h-X diagrams. Solid-gas absorption systems: Working pairs, Basic cycle and principle of operation.

(7 hours)

Module 4

Psychrometry: Properties of moist air and their estimation, Psychrometric chart, Psychrometric Processes (Sensible cooling/heating, cooling and dehumidification, heating and humidification, Mixing of air streams, Adiabatic saturation)

Psychrometry of air conditioning systems: Summer air conditioning (Systems with full recirculation and ventilated air) and fixing supply condition, Determination of RSHF, GSHF, ADP and BPF, Year round air conditioning system

(7 hours)

Module 5

Automotive Air Conditioning Systems

Distribution ducting and their sizing, type of grills, diffusers, ventilation, filtration, layout of duct systems for automobiles. Common controls such as thermostats, humidistat, control dampers, pressure cut-outs, relays. Dashboard re-circulating unit, Temperature/flow control in auto air conditioning systems. Refrigerant charging, Testing, Diagnosis & trouble shooting of air conditioning system.

(7 hours)

Text Books

1. C P Arora, Refrigeration and Air Conditioning by, McGraw-Hill India Publishing Ltd.
2. Manohar Prasad, Refrigeration and Air Conditioning by, New Age International Publisher

Reference Books

1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Roy. J Dossat, Principles of Refrigeration, Pearson Education
3. W.F. Stocker and J. W. Jones, Refrigeration and Air Conditioning, McGraw-Hill
4. Crouse and Anglin, Automobile Air conditioning McGraw Hill Publications
5. Paul Weisler, "Automotive Air Conditioning", Reston Publishing Co. Inc., 1990.
6. McDonald, K.L., "Automotive Air Conditioning", Theodore Audel series, 1978.
7. Mark Schnubel, Automotive engineering-Heating and Air conditioning, Cengage Learning, 2009

NPTEL Resources:

Refrigeration and Air Conditioning, Prof. M. Ramgopal, IIT Kharagpur

Course Contents and Lecture Plan

No.	Topic	No. of Lectures
1	Introduction to auto HVAC systems:	
1.1	History of auto air conditioning,	1
1.2	Overview of technologies	1
1.3	Development of refrigerants and compressors, Applications.	1
1.4	Refrigerants: Primary and secondary refrigerants	1
1.5	Nomenclature of refrigerants	1
1.6	Thermo-physical properties and Selection of refrigerants	1
1.7	Mixed refrigerants	1
2	Vapour Compression Refrigeration System (VCRS)	
2.1	Units of refrigeration COP, EER and SEER	1
2.2	Carnot refrigeration cycle	1
2.3	Standard vapour compression refrigeration system	1
2.4	Effect of condenser and evaporator temperature on performance	1
2.5	Effect of sub cooling and superheating	1
2.6	Actual VCRS system, Multistage VCRS	1
2.7	Flash gas removal and flash intercooling	1
2.8	Multi evaporator and cascade systems	1
3	Vapour Absorption Refrigeration System (VARs)	

3.1	Relevance of VARS, basic principle of operation of VARS, Max. COP	1
3.2	Refrigerant absorbent mixtures and their properties	1
3.3	Raoult's law, Ideal and real mixtures	1
3.4	Ammonia-water VARS. PTX and h-X diagrams	1
3.5	Solid-gas absorption systems	1
3.6	Working pairs	1
3.7	Basic cycle and principle of operation	1
4	Psychrometry	
4.1	Properties of moist air and their estimation, Psychrometric chart	1
4.2	Psychrometric Processes (Sensible cooling/heating, cooling and dehumidification)	1
4.3	(heating and humidification, Mixing of air streams, Adiabatic saturation)	1
4.4	Psychrometry of air conditioning systems: Summer air conditioning (Systems with full recirculation and ventilated air)	1
4.5	Fixing supply condition	1
4.6	Determination of RSHF, GSHF, ADP and BPF	1
4.7	Year round air conditioning system	1
5	Automotive Air-Conditioning systems	
5.1	Distribution ducting and their sizing, type of grills, Diffusers, ventilation, filtration	1
5.2	Layout of duct systems for automobiles	1
5.3	Common controls such as thermostats, humidistat	1
5.4	Control dampers, pressure cutouts, relays	1
5.5	Dashboard re-circulating unit, Temperature/flow control in auto air conditioning systems	1
5.6	Refrigerant charging, Testing	1
5.7	Diagnosis & trouble shooting of air conditioning system.	1

MUT342	ELECTRIC VEHICLE TECHNOLOGY	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims at providing

1. Understand the basic concept of Electric Vehicle Technology.
2. To understand about drives and controls used in Electric Vehicles
3. To know about Select battery, battery indication system for EV applications
4. To understand the energy drives used in EV applications
5. To know about Connected Mobility and Autonomous Mobility

Prerequisite:

MUT 203 AUTO CHASSIS

MUT 307 AUTO TRANSMISSION

MUT 301 AUTO ELECTRICAL/ ELECTRONICS

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

CO 1	To understand the basics of electric vehicle technology
CO 2	To familiarize with drives and controls used in Electric Vehicle Technology
CO 3	Identify and analyse the dynamics systems such as suspension systems, body vibrations, steering mechanisms.
CO 4	To analyse and solve engineering problems related to vehicle dynamics
CO 5	Comparing and identifying the different types of control systems in automobiles

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	1
CO 2	2	1	1	-	-	1	-	-	-	-	-	1
CO 3	2	2	1	-	1	-	-	-	-	-	-	1
CO 4	2	2	1	-	1	-	-	-	-	-	-	1
CO 5	2	1	1	-	2	-	-	-	-	1	-	1

Assessment Pattern

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

Create			
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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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Are you able to understand the concept of Electric Vehicle Technology?

Course Outcome 2 (CO2)

1. Did you understand different configuration of Electric vehicles based on drive?
2. Did you get the basic concept of various hybrid vehicles?

Course Outcome 3(CO3):

1. Did you get the idea about various storage batteries used in Electric vehicles?
2. Did you get the concept of various range extending technologies used in electric vehicles?

Course Outcome 4 (CO4):

1. Are you able to know the various types of energy drives or electric motors used for electric vehicles?

Course Outcome 5 (CO5):

1. Did you understand the challenges in charging the electric vehicles and the various types used?

MODEL QUESTION PAPER**QP CODE:****PAGES:...****Reg. No:** _____**Name :** _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MUT 342

Course Name: Electric Vehicle Technology

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

(Answer all questions. Each question carry 3 marks)

1. Why electric vehicles are gaining the attention of automotive industry?
2. State the disadvantages of electric vehicles over IC engine vehicles?
3. How the drive motor is controlled in electric vehicle? Describe briefly.
4. What are the advantages of hybrid vehicles over electric vehicles?
5. What is the chemical reaction involved in a lead acid battery? Explain briefly
6. What is regenerative braking? How it helps in extending the range of EV?
7. What is the torque characteristics needed from a electric motor?
8. State the advantages of BLDC motor
9. What are the challenges in implementing Emobility with respect charging infrastructure in India?
10. What is the charging time required in conventional charging methods? How it can be resolved?

Part B

Answer any one full question from each module.

Each question carries 14 Marks

11. a) Explain how electric vehicles are evolved in India and World (7)
 b) Explain the concept of Formula e Cars (7)
- OR**
12. (a) Describe the scope of autonomous electric vehicles. (7)
 (b) How energy saving and emission reduction is achieved by electric vehicles? (7)
- 2014
13. (a) Explain the types of electric drive arrangements used in EVs (9)
 (b) Differentiate between series and parallel hybrid vehicles (5)
- OR**
14. Explain the salient features of electric bus. What are the challenges faced in using the electric bus for mass transportation? (14)
15. a) Explain the constructional features of Lithium ion batteries with chemical reaction involved (7)

- b) How Nickel Metal hydride batteries works? Explain (7)
OR
16. (a) How flywheel based energy system works? Explain with sketch (7)
(b) Explain the concept of regenerative braking with a neat sketch (7)
17. Explain the constructional features of a basic DC Motor and explain its torque characteristics (14)
OR
18. (a) Explain the constructional features of BLDC motor with a neat sketch (7)
(b) What are the various strategies for improving the cooling and efficiency of electric motors used in EVs (7)
19. What are the various EV charging standards? Explain the challenges in Emobility and electrification challenges in India. (14)
OR
20. Explain the concepts of V2G, G2V, V2B and V2H and their importance in EVs (14)

Syllabus: MUT 342 - ELECTRIC VEHICLE TECHNOLOGY**2-1-0**

MODULE I – Introduction to Electric Vehicle Review of Conventional Vehicle: Introduction to Electric Vehicles: History and development of Electric Vehicles, Types of EVs, Electric vehicles and environment, Energy Saving and Overall Reduction of Carbon Emission, Costs and emissions, introduction to autonomous/ self driving cars, Formula e cars, Tractive effort in normal driving Mode.

MODULE II – Electric drive train: Electric vehicle drive layout, types of electric drive arrangements, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Electric Propulsion unit, Constructional Features of Electric Bus.

MODULE III– Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles: - Battery based energy storage and its analysis, Lead Acid Battery Basics, Special Characteristics of Lead Acid Batteries, Nickel-Based Batteries - Nickel Cadmium and Nickel Metal Hydride Batteries, Lithium Batteries - Lithium Polymer Battery, The Lithium Ion Battery Metal–Air Batteries, Range extending with regenerative braking, flywheel based energy storage system, Super capacitors

MODULE IV- Energy drives: ‘Brushed’ DC Electric Motor, Operation of the Basic DC Motor, Torque Speed Characteristics, Controlling the Brushed DC Motor, Electric Motors as Brakes, Switching Devices, Step-Down or ‘Buck’ Regulators, Step-Up or ‘Boost’ Switching

Regulator , Brushless DC Motor, Switched Reluctance Motors, The Induction Motor, Motor Cooling, Efficiency, Size and Mass, Improving Motor Efficiency,

MODULE V –

Energy Management Strategies, Automotive networking and communication, EV charging standards, V2G, G2V, V2B, V2H. Business: E-mobility business, electrification challenges, Business- E-mobility business, electrification challenges.

Emobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. Connectors- Types of EV charging connector, North American EV Plug Standards, DC Fast Charge EV Plug Standards in North America, CCS (Combined Charging System), CHAdeMO, Tesla, European EV Plug Standards,

Text Books

1. James, and John Lowry, “Electric Vehicle Technology Explained” John Wiley and Sons, 2012
2. Singiresu S. Rao, “Mechanical Vibrations”, 5th Edition, Prentice Hall, 2010
3. Thomas D. Gillespie, “Fundamentals of Vehicle Dynamics”, Society of Automotive Engineers Inc, 1992
4. Wong. J. Y., “Theory of Ground Vehicles”, 3rd Edition, Wiley-Interscience, 2001
5. N.K. Giri, Automotive Mechanics, Kanna Publishers, 2007

Reference Books

1. Emadi, A. (Ed.), Miller, J., Ehsani, M., “Vehicular Electric Power Systems” Boca Raton, CRC Press, 2003
2. Husain, I. “Electric and Hybrid Vehicles” Boca Raton, CRC Press, 2010.
3. Tariq Muneer and Irene IllescasGarcía, “The automobile, In Electric Vehicles: Prospects and Challenges”, Elsevier, 2017
4. Sheldon S. Williamson, “Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles”, Springer, 2013.

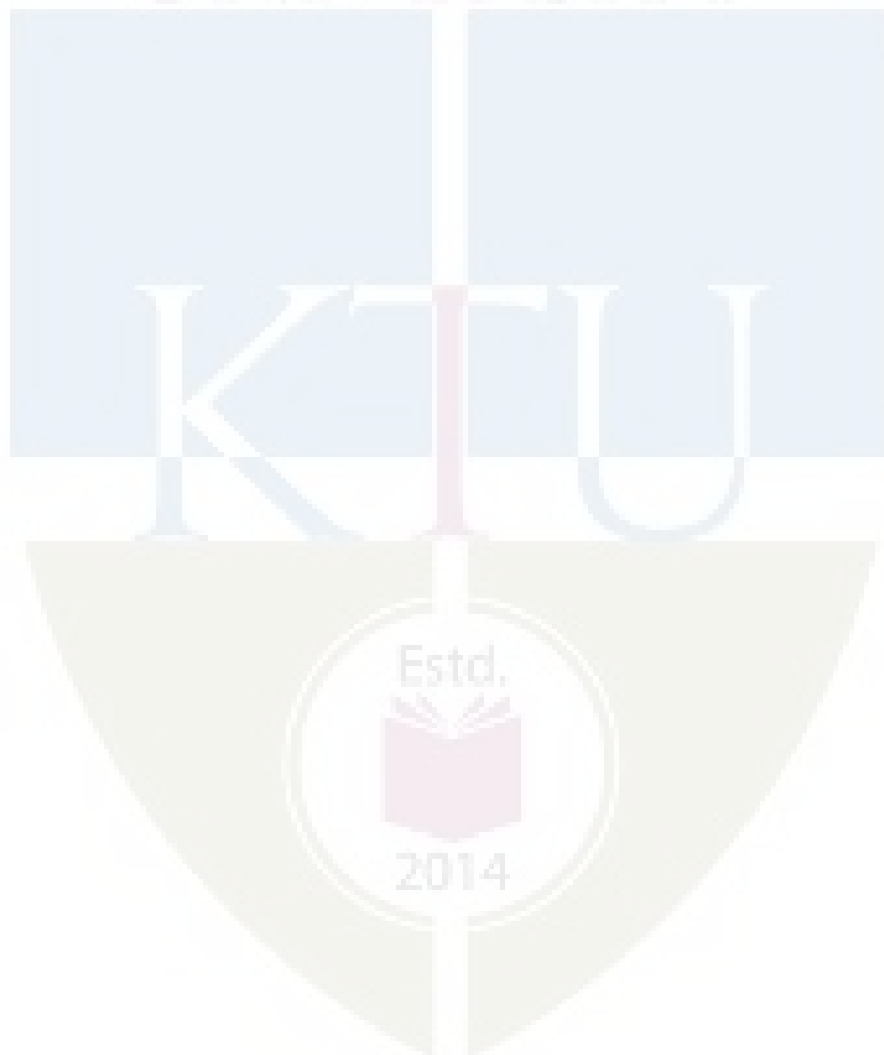
Course Contents and Lecture Schedule

No	Topic	No. of Lectures
Introduction - Discussion on syllabus, Cos and POs		
1	Introduction to Electric Vehicle	
1.1	Review of Conventional Vehicle	1
1.2	Introduction to Electric Vehicles: History and development of Electric Vehicles	1
1.3	Types of EVs, Electric vehicles and environment	1

1.4	Energy Saving and Overall Reduction of Carbon Emission	1
1.5	Costs and emissions	1
1.6	Introduction to autonomous/ self driving cars	1
1.7	Formula e cars, Tractive effort in normal driving Mode	1
2	Electric drive train	
2.1	Electric vehicle drive layout	1
2.2	Types of electric drive arrangements	2
2.3	Energy consumption Concept of Hybrid Electric Drive Trains	1
2.4	Architecture of Hybrid Electric Drive Trains	1
2.5	Series Hybrid Electric Drive Trains	1
2.6	Parallel hybrid electric drive trains	1
2.7	Electric Propulsion unit, Constructional features of Electric Bus	1
3	Energy Storage	
3.1	Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles	1
3.2	Battery based energy storage and its analysis	1
3.3	Lead Acid Battery Basics, Special Characteristics of Lead Acid Batteries	1
3.4	Nickel-Based Batteries - Nickel Cadmium and Nickel Metal Hydride Batteries	1
3.5	Lithium Batteries - Lithium Polymer Battery	1
3.6	The Lithium-Ion Battery Metal–Air Batteries	1
3.7	Regenerative braking, Flywheel based energy storage system	1
4	Energy drives	
4.1	‘Brushed’ DC Electric Motor, Operation of the Basic DC Motor	1
4.2	Torque Speed Characteristics, Controlling the Brushed DC Motor	1
4.3	Motors as Brakes, Switching Devices	1
4.4	Step-Down or ‘Buck’ Regulators, Step-Up or ‘Boost’ Switching Regulator	1
4.5	Brushless DC Motor, Switched Reluctance Motors	1
4.6	The Induction Motor, Motor Cooling, Efficiency	1
4.7	Size and Mass, Improving Motor Efficiency, Super Capacitors	1
5	Energy Management Strategies and E-Mobility Indian Roadmap Perspective	
5.1	Energy Management Strategies, Automotive networking and communication	1
5.2	EV charging standards, V2G, G2V, V2B, V2H	1
5.3	Business- E-mobility business, electrification challenges.	1
5.4	Emobility Indian Roadmap Perspective. Policy: EVs in	1

	infrastructure system	
5.5	Integration of EVs in smart grid, social dimensions of EVs	1
5.6	Connectors- Types of EV charging connector, North American EV Plug Standards	1
5.7	DC Fast Charge EV Plug Standards in North America, CCS (Combined Charging System), CHAdeMO, Tesla, European EV Plug Standards	1

ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY



MUT362	PRODUCT LIFE CYCLE MANAGEMENT	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims at providing

1. Understand product life cycle management, its scope and opportunities.
2. Identify the drivers and enablers of product life cycle management
3. To Understand the environmental aspects of product life cycle management
4. To familiarise with PLM software and to discuss the case studies of PLM implementation in various industries.

Prerequisite: HUT300 INDUSTRIAL ECONOMICS & FOREIGN TRADE

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

CO 1	To familiarise with product life cycle management, its scope and opportunities.
CO 2	To identify the components of product life cycle management
CO 3	Identify and analyse the product life cycle management & its drivers
CO 4	To understand product data management its integration of environmental aspects in product design
CO 5	To understand and familiarise with PLM software and to discuss and classify the case studies of PLM implementation in various industries

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
CO 2	2	1	1	-	-	1	2	-	-	-	-	2
CO 3	2	1	1	-	-	1	2	-	-	-	-	2
CO 4	2	1	1	-	-	1	2	-	-	-	-	2
CO 5	2	2	1	2	3	1	2	-	-	-	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	50
Apply	10	10	20
Analyse	10	10	20
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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Can you able to make acquainted with product life cycle management, its scope and opportunities.?

Course Outcome 2 (CO2)

1. Can you evaluate and identify the components of product life cycle management?

Course Outcome 3(CO3):

1. Can you identify and analyse the product life cycle management & its drivers

Course Outcome 4 (CO4):

1. Are you able to understand product data management its integration of environmental aspects in product design?

Course Outcome 5 (CO5):

1. Can you able to understand and familiarise with PLM software and to discuss and classify the case studies of PLM implementation in various industries?

MODEL QUESTION PAPER**QP CODE:****PAGES:...****Reg. No:** _____**Name :** _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: MUT362**Course Name: PRODUCT LIFE CYCLE MANAGEMENT****Max. Marks: 100****Duration: 3 Hours****Part A****(Answer all questions. Each question carry 3 marks)**

1. Discuss briefly the basic principle definitions of product life cycle management.
2. Explain the term PLM grid.
3. What are the different phases of product lifecycle management.
4. What do you understand by PLM model.
5. Discuss the importance of PDM systems.
6. Explain the terms traceability and reflectiveness.
7. Define cycle cost analysis.
8. What do you understand by the term 'Design for Environment' , explain in detail.
9. Discuss the importance of PDM systems.
10. What is meant by PLM visioning, explain with an example?

Part B**Answer any one full question from each module.****Each question carries 10 Marks**

11. Discuss the various stages of product life cycle, and explain how PLM strategies are used in the various stages using a case example. (14)
- OR**
12. (a) Explain the role of customer in PLM. (7)
 - (b) Discuss the history and emergence of PLM. (7)
13. . a) Define engineering data management (EDM). (7)
 - b) Explain the foundation technologies and standards of PLM. (7)
- OR**
14. With the help of a case example explain the role of human resources in product lifecycle management? (14)
 15. a) Discuss the importance of PDM systems and its components . (7)
 - b) Differentiate between PLM and ERP. (7)
- OR**
16. (a) Explain information mirroring model. (7)

(b) What are the external drivers of PLM explain with examples. (7)

OR

17. Discuss the different strategies in Product Design for Sustainable Development and its importance in PLM. (14)

OR

18. What do you understand by LCA discuss the fields of Application and Limitations of Life Cycle Assessment. (14)

19. With the help of a case example explain the steps involved in PLM implementation. (14)

OR

20. Explain the salient features of any two commercial PLM/PDM software. (14)

Syllabus: MUT362– PRODUCT LIFE CYCLE MANAGEMENT

2-1-0

Module 1: INTRODUCTION

Introduction to product life cycle management– Introduction, growth, maturity & decline, Product Lifecycle Management- Definition & Overview, benefits of PLM, PLM scope and the PLM grid, Background for PLM-corporate challenges, Need of PLM, Components/Elements of PLM, steps and activities of PLM initiative (case study). Emergence of PLM, Significance of PLM - life cycle problems to be resolved, product development problems to be resolved, Customer Involvement.Reasons for the deployment of PLM systems.

Module 2: COMPONENTS OF PRODUCT LIFE CYCLE MANAGEMENT

Different phases of product lifecycle and corresponding technologies, Foundation technologies and standards e.g. visualization, collaboration and enterprise application integration, Core functions e.g., data vaults, document and content management, workflow and program management, Functional applications e.g., configuration management. Human resources in product lifecycle. PLM Case Study. PLM model- plan, design, build, support & dispose. Product life cycle management system- system architecture, Information models and product structure, Threads of PLM computer aided design (CAD), engineering data management (EDM),

Module 3: PRODUCT LIFE CYCLE MANAGEMENT & ITS DRIVERS

Product data management (PDM),Product Data Management (PDM) ,PDM systems and importance, Components of PDM, Reason for implementing a PDM system, Financial justification of PDM, Barriers to PDM implementation. computer integrated manufacturing (CIM). Weaving the threads into PLM, comparison of PLM to Engineering resource planning (ERP).PLM characteristics - singularity, cohesion, traceability, reflectiveness, Information mirroring model. External drivers- scale, complexity, cycle times, globalization & regulation.

Internal drivers - productivity, innovation, collaboration & quality. Board room drivers – income, revenues & costs.

Module 4: PRODUCT DATA MANAGEMENT AND INTEGRATION OF ENVIRONMENTAL ASPECTS IN PRODUCT DESIGN

Product and Product Data Product Importance, Range, Parts, Ingredients, Components, Assemblies, Identifier, Requirements From Customer, Requirement to Product Specification, Identification Standards, Unique Identifier, Unique Key, Traceability. Collaborative Product Development. Integration of Environmental Aspects in Product Design Sustainable Development, , Design for X System and tools, Design for Disassembly, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design. Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis, Case Studies in LCA and LCCA

Module 5: ROLE OF PLM IN INDUSTRIES

PDM systems and importance, reason for implementing a PDM system, financial justification of PDM implementation. Case studies on PLM selection and implementation (like auto, aero and other manufacturing industries)-other possible sectors, Components and Phases of PLM, PLM feasibility study, PLM visioning, PLM strategy, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organisation, users, product or service, process performance. Case studies based on top few commercial PLM/PDM softwares.

Text Books

1. **Grieves Michael**, Product Lifecycle Management- Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006. ISBN 0071452303
2. **Antti Saaksvuori, Anselmi Immonen**, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003)
3. **Stark, John**. Product Lifecycle Management: 21st Century Paradigm for Product Realization, Springer-Verlag, 2004. ISBN 1852338105.

Reference Books

1. **Fabio Giudice, Guido La Rosa, Antonino Risitano**, “Product Design for the environment-A life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229

2. **Karl Ulrich, Steven Eppinger**, “Product Design and Development”, McGraw Hill Education, 2008, ISBN- 9780070146792
3. **Jack R. Meredith and Samuel J. Mantel**, “Technology Forecasting”, 1995, John Wiley and Sons

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction - Discussion on syllabus, Cos and POs	
1.1	Introduction to product life cycle management– Introduction, growth, maturity & decline	1
1.2	, Product Lifecycle Management- Definition & Overview, benefits of PLM, PLM scope and the PLM grid	2
1.3	, Background for PLM-corporate challenges, Need of PLM, Components/Elements of PLM, steps and activities of PLM initiative (case study).	1
1.4	Emergence of PLM, Significance of PLM - life cycle problems to be resolved,	2
1.5	product development problems to be resolved, Customer Involvement.Reasons for the deployment of PLM systems.	1
2	COMPONENTS OF PRODUCT LIFE CYCLE MANAGEMENT	
2.1	Different phases of product lifecycle and corresponding technologies, Foundation technologies and standards e.g. visualization, collaboration and enterprise application integration,	2
2.2	Core functions e.g., data vaults, document and content management, workflow and program management, Functional applications e.g., configuration management.	2
2.3	Human resources in product lifecycle. PLM Case Study. PLM model- plan, design, build, support & dispose.	1
2.4	Product life cycle management system- system architecture, Information models and product structure	1
2..5	, Threads of PLM computer aided design (CAD), engineering data management (EDM),	1
3	PRODUCT LIFE CYCLE MANAGEMENT & ITS DRIVERS	
3.1	Product data management (PDM),Product Data Management (PDM) ,PDM systems and importance,	1
3.2	Components of PDM, Reason for implementing a PDM system, Financial justification of PDM, Barriers to PDM implementation. computer integrated manufacturing (CIM).	1
3.3	Weaving the threads into PLM, comparison of PLM to	2

	Engineering resource planning (ERP).	
3.4	PLM characteristics - singularity, cohesion, traceability, reflectiveness, Information mirroring model.	1
3.5	External drivers- scale, complexity, cycle times, globalization & regulation. Internal drivers - productivity, innovation, collaboration & quality. Board room drivers – income, revenues & costs.	2
4	PRODUCT DATA MANAGEMENT AND INTEGRATION OF ENVIRONMENTAL ASPECTS IN PRODUCT DESIGN	
4.1	Product and Product Data Product Importance, Range, Parts, Ingredients, Components, Assemblies, Identifier, Requirements From Customer, Requirement to Product Specification, Identification Standards, Unique Identifier, Unique Key, Traceability.	2
4.2	Collaborative Product Development. Integration of Environmental Aspects in Product Design Sustainable Development, , Design for X System and tools, Design for Disassembly, Design for Environment, Need for Life Cycle Environmental Strategies.	2
4.3	Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design.	1
4.4	Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment,	1
4.5	Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis, Case Studies in LCA and LCCA	1
5	ROLE OF PLM IN INDUSTRIES	
5.1	PDM systems and importance, reason for implementing a PDM system, financial justification of PDM implementation.	2
5.2	Case studies on PLM selection and implementation (like auto, aero and other manufacturing industries)-other possible sectors,	1
5.3	Components and Phases of PLM, PLM feasibility study, PLM visioning, PLM strategy, change management for PLM, financial justification of PLM,	2
5.4	barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organisation, users, product or service, process performance.	1
5.5	Case studies based on top few commercial PLM/PDM softwares.	1

MUT 372	NUCLEAR ENGINEERING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: The aim of this subject is to provide students with a general understanding of the fundamentals and applications of nuclear engineering. So the purpose of this course is to expose the student.

- ✓ To introduce the various basic concepts in nuclear engineering
- ✓ Understanding the theory of nuclear reactors.
- ✓ Analyse the performance comparison of various types of reactors configurations.
- ✓ Understanding the importance of computer codes and modelling
- ✓ To impart basic knowledge on materials used in reactors.
- ✓ To understand health effects of radiation.
- ✓ to introduce the concepts of radiation hazards and shielding

Prerequisite: NIL

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

CO 1	Understand the important nuclear engineering concepts and radioactivity
CO 2	Understanding the neutron production and its reaction with nuclei
CO 3	Illustrate the different types of reactors and their performance comparison. Examine the role of computers in modern reactor modelling.
CO 4	Understanding on the application of isotopes and materials in nuclear reactor
CO 5	Understand the health effects of low and high doses of ionizing radiation Build a conceptual design of nuclear propulsion systems

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	2	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-
CO 4	3	2	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	

Remember	25	25	50
Understand	25	25	50
Apply			
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 anyone. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Explain the term mass defect and binding energy.
2. Compare the fundamental properties of rays and elementary particles from radioactive materials-mass, charge, shape, spin, magnetic moment.
3. What do you mean by nuclear stability?
4. State and explain the Laws of radioactive decay
5. Write down the various decay schemes of radioactive nuclei
6. With the help of neat sketches explain the operation of any two particle accelerators

Course Outcome 2(CO2):

1. Explain the liquid drop model of nuclear fission.
2. Explain the terms- neutron flux, cross-section and mean free path
3. Describe in details about the absorption type of neutron reactions with nuclei

4. Discuss the variations of cross – section with neutron energy
5. Write short notes on the amounts and activities of fission products during operation and shut down
6. Discuss about the heat generation after shut down of a nuclear reactor.

Course Outcome 3 (CO3):

1. List five advantages and five disadvantage of a pressurised water reactor.
2. List five advantages and five disadvantage of a Boiling water reactor.
3. List five advantages and five disadvantage of a Sodium Graphite reactor.
4. List five advantages and five disadvantage of a Fast Breeder reactor.
5. List five advantages and five disadvantage of a Homogeneous reactor.
6. Explain the role of computers and coding in the mathematical modelling of nuclear weapon reactors

Course Outcome 4 (CO4):

1. What are the uses of radioactive isotopes in chemistry and biology?
2. What are the uses of radioactive isotopes in medicine and agriculture?
3. What are process tracers?
4. What is the Industrial application of isotopes in activation analysis?
5. Discuss the isotope application in Wear studies and thickness gages.
6. Describe the essential requirements of Moderator and Reflector materials.

Course Outcome 5 (CO5):

1. Define the term REM
2. What is meant by Radiation shielding?
3. What are the various shielding materials.?
4. Explain the propulsion system in Nuclear submarines and Nuclear ships.

Model Question paper**QP CODE:****PAGES: 2****Reg. No:** _____**Name :** _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: MUT372**Course Name: NUCLEAR ENGINEERING****Max. Marks: 100****Duration: 3 Hours****PART A****Answer all Questions.****Each question carries 3 Marks (2 questions from each module)**

- 1) Determine the binding energy per nucleon of an isotopic mass of ${}_{92}\text{U}^{235}$.
- 2) Calculate the activity in curies of 1 mg of tritium (${}_{1}\text{H}^3$)
- 3) Explain the liquid drop model of nuclear fission.
- 4) Write the expression for Briet-Wigner formula. what is its use?
- 5) How are nuclear fission reactors are classified?
- 6) List two advantages and one disadvantage of a pressurised water reactor.
- 7) Mention the uses of radioactive isotopes in medicine and agriculture
- 8) Find out the most common fuel material in commercial power reactors, mention its two advantages.
- 9) What are the three main aspects in the problem of shielding the reactor?
- 10) What is meant by dose rate and radioactive source strength?

PART B**Answer any one full question from each module.****Each question carries 14 Marks****Module 1**

- 11) With the help of neat sketches explain the operation of any two particle accelerators.

Or

- 12) (a) Calculate the decay constant for U-235, half-life is 8.5×10^8 years. (7 marks)

(b) How many disintegrations per second are there in 1-gram sample of U-235? What number of curies is this? (7 marks)

Module 2

13) (a) The average energy of neutrons released in the fission process is 1.935Mev. calculate the neutron speed that corresponds to this energy. (7 marks)

(b) What will be the temperature of a graphite block containing neutrons in thermal equilibrium, with most probable speed 2600 m/s ? (7 marks)

Or

14) Describe in details about the absorption type of neutron reactions with nuclei

Module 3

15) Make a detailed comparison between boiling water and sodium graphite reactor.

Or

16) Explain the role of computers and coding in the mathematical modelling of nuclear weapon reactors.

Module 4

17) Explain any three industrial application of isotopes, in detail

Or

18) Describe the various instrumental techniques for detection and measurement of radioactivity.

Module 5

19) Discuss the Somatic and genetic effects of Radiation.

Or

20) What is the main advantage of using a nuclear fuel in longer space voyage missions? Explain with a schematic diagram, the construction and features of a Nuclear iconic spaceship.

SYLLABUS

Module 1

Nuclear Engineering Basic Concepts- Nuclear structure of matter, Fundamental properties of rays and elementary particles from radioactive materials-mass, charge, shape, spin, magnetic moment, size of nucleus, binding energy, packing fraction and nuclear stability.

Radioactivity – Laws of radioactive decay, half-life, mean life, specific activity, radioactive decay calculations, Nuclear reactions and artificial radioactivity, decay schemes of radioactive nuclei, particle accelerators.

Module 2

Neutrons, Fission and chain reactions- General properties and production of neutrons, Neutron temperature, neutron reactions-absorption and scattering, the Maxwell-Boltzmann distribution, neutron flux, cross-section and mean free path, variations of cross – section with neutron energy, Briet-Wigner formula, Doppler effect, thermal neutron cross sections

Fission and chain reactions- Uranium fission, critical mass, mechanism of nuclear fission, Fission cross section, rate and Reaction Power, Fission, Prompt and Delayed Neutrons, Amounts and activities of fission products during operation and shut down, heat generation after shut down.

Module 3

Nuclear reactor principles and Types-History of reactor development, Classification of nuclear fission reactors, pressurised water reactor(PWR), Boiling water reactor (BWR), Sodium Graphite reactor, Fast breeder reactor (FBR), Gas cooled reactors, Homogeneous and other reactor concepts. General principles of evaluating power reactors, Role of computers in the mathematical modelling of nuclear reactor.

Module 4

Isotopes – Relative advantages of stable and radioactive isotopes, uses in chemistry, biology, medicine and agriculture. Industrial application of isotopes- process tracers, X-rays, Activation analysis, Wear studies, flow and level measurements, thickness gages, Uses of fission product wastes. Instrumental techniques for detection and measurement of radioactivity.

Fuel Materials - uranium dioxide fuel, Plutonium fuels, Thorium Fuel materials, coated particle fuels for gas cooled reactors,

Moderator and Reflector materials - essential requirements of these materials, Graphite, Ordinary water, Heavy water, radiation decomposition of water, Zirconium Hydride.

Module 5

Radiation Hazards and shielding – health effects of different types of radiation, maximum permissible external dosage, internal exposure, calculation of maximum permissible concentrations, photon flux, dose rate and radioactive source strength, Rem, Biological effects of Radiation-Somatic and genetic effects. Radiation shielding – sources of radiation, Heat

generation in shields, Thermal and Biological shields, reactor shielding requirements, shielding materials.

Nuclear Propulsion – submarines, Nuclear ships, Nuclear aircraft, Nuclear ionic spaceship.

Text Books

1	Nuclear Reactor Engineering	Samuel Glasstone & Alexander Sesonske	CBS Publishers & distributors Pvt.Ltd
2	Introduction to Nuclear Engineering	Raymond L. Murray	Prentice- Hall, Inc.
3	Nuclear Engineering	Charles F. Bonilla	McGraw - Hill book company, Inc.

Reference Books

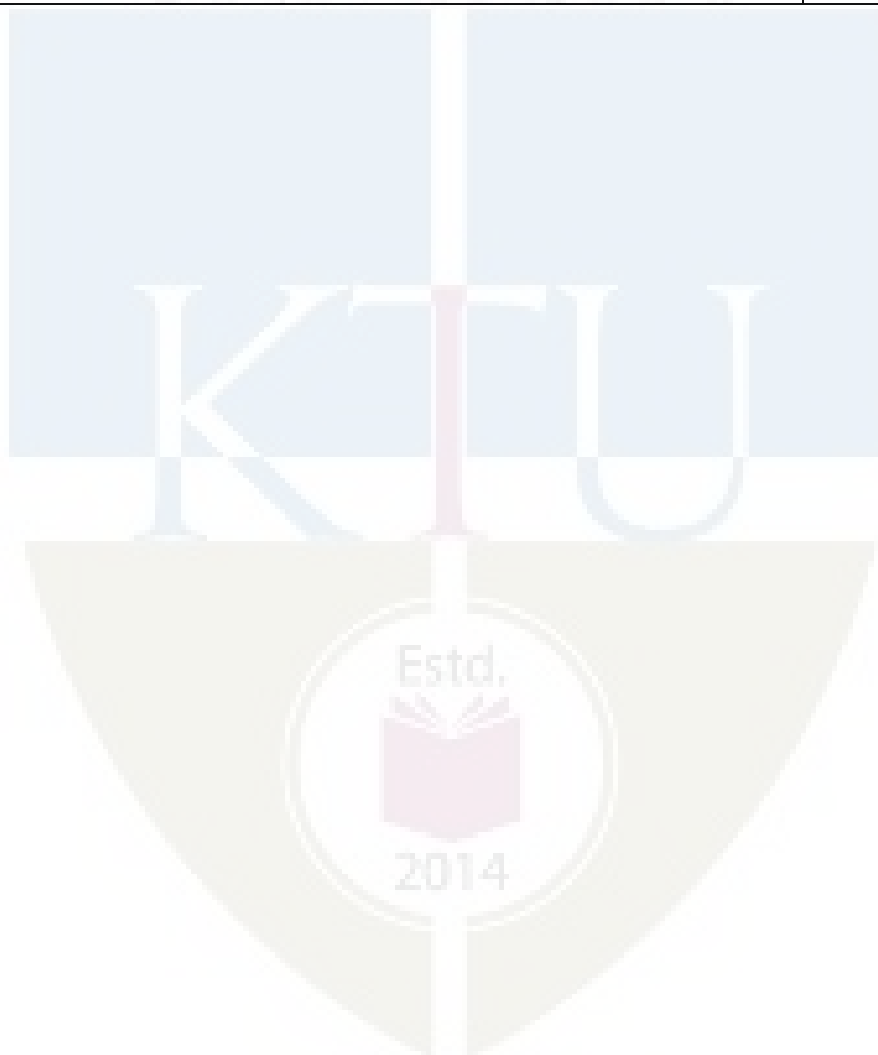
1	Nuclear Physics	D.C. Tayal	Himalayan Publication house, Bombay ,1980.
2	Nuclear Physics	Irving Kaplan	Narosa Book Distributors, 2002.
3	Radiation detection and measurement	G.F. Knoll	John Wiley & Sons, 3ed, London, 2000.
4	Introduction to Nuclear Engineering	J. R. Lamarsh, A. J. Baratta	Prentice-Hall, 2001.
5	Medical Physics, Volume I, II, III	Glasser O.	The year book publishers Inc., Chicago 1980.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	Module 1 (7 hours)	
1.1	Nuclear structure of matter, Fundamental properties of rays and elementary particles from radioactive materials-mass, charge, shape, spin, magnetic moment, size of nucleus,	2
1.2	Binding energy, packing fraction and nuclear stability.	1
1.3	Laws of radioactive decay, half-life, mean life, specific activity,	1

	radioactive decay calculations	
1.4	Nuclear reactions and artificial radioactivity, decay schemes of radioactive nuclei	2
1.5	Particle accelerators.	1
2	Module 2 (7 hours)	
2.1	General properties and production of neutrons, Neutron temperature	1
2.2	Neutron reactions-absorption and scattering, the Maxwell-Boltzmann distribution, neutron flux, cross-section and mean free path, variations of cross – section with neutron energy, Briet-Wigner formula, Doppler effect, thermal neutron cross sections	3
2.3	Uranium fission, critical mass, mechanism of nuclear fission	1
2.4	Fission cross section, rate and Reaction Power, Fission, Prompt and Delayed Neutrons, Amounts and activities of fission products during operation and shut down, heat generation after shut down.	2
3	Module 3 (7 hours)	
3.1	History of reactor development, Classification of nuclear fission reactors.	1
3.2	pressurized water reactor(PWR), Boiling water reactor (BWR), Sodium Graphite reactor.	2
3.3	Fast breeder reactor (FBR), Gas cooled reactors, Homogeneous and other reactor concepts.	2
3.4	General principles of evaluating power reactors,	1
3.5	Role of computers in the mathematical modelling of nuclear reactor.	1
4	Module 4 (7 hours)	
4.1	Relative advantages of stable and radioactive isotopes, uses in chemistry, biology, medicine and agriculture.	1
4.2	Industrial application of isotopes- process tracers, X-rays, Activation analysis, Wear studies, flow and level measurements, thickness gages, Uses of fission product wastes.	2
4.3	Instrumental techniques for detection and measurement of radioactivity.	2
4.4	uranium dioxide fuel, Plutonium fuels, Thorium Fuel materials, coated particle fuels for gas cooled reactors.	1
4.5	Essential requirements of Moderator and Reflector materials - Graphite, Ordinary water, Heavy water, radiation decomposition of water, Zirconium Hydride.	1

5	Module 5 (7 hours)	
5.1	Health effects of different types of radiation, maximum permissible external dosage, internal exposure, calculation of maximum permissible concentrations	1
5.2	photon flux, dose rate and radioactive source strength, Rem.	1
5.3	Biological effects of Radiation-Somatic and genetic effects.	1
5.4	Radiation shielding – sources of radiation, Heat generation in shields, Thermal and Biological shields.	2
5.5	Reactor shielding requirements, shielding materials.	1
5.6	Nuclear Propulsion – Submarines, Nuclear ships, Nuclear aircraft, Nuclear ionic spaceship.	1



APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

SEMESTER VI

MINOR



AUT 382	COURSE NAME: MODERN AUTOMOTIVE TECHNOLOGY	CATEGORY	L	T	P	CREDIT
		VAC	4	0	0	4

Preamble: The aim of this subject is to provide students with a general understanding of the advanced developments in modern Automobile engineering.

Pre-requisite: Auto chassis, power plant, Auto electrical and electronics.

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

CO 1	Understand the construction and working of different electric and Hybrid Vehicle technology.
CO 2	Exemplify the significance of alternate power plants for automobiles and different modes of operation for optimum use.
CO 3	Understand the navigation and driver assistance systems used in modern vehicles.
CO 4	Understand the application of electronic and microcontroller systems incorporated in modern automobiles.
CO 5	Understand the construction and working of different types of fuel cells and auxiliary systems.

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	-	1	1	-	-	2	-	1
CO 2	2	1	-	2	-	1	2	-	-	2	-	1
CO 3	2	1	-	1	-	1	1	-	-	2	-	1
CO 4	2	-	-	-	-	1	1	-	-	2	-	1
CO 5	2	1	-	1	-	2	2	-	-	2	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
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 maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Discuss the components and the working of battery electric vehicles
2. Distinguish between BEVs and PBEVs
3. Explain the different layouts of Hybrid vehicles
4. With an example explain the Control system for hybrid vehicles.

Course Outcome 2 (CO2)

1. Explain the principle of operation of a stratified charge engine
2. What are the methods used for charge stratification?
3. Illustrate the operation of an RCCI engine.
4. Distinguish between open loop and closed loop systems.

Course Outcome 3(CO3):

1. What are the modern navigation systems used in automobiles?
2. What is GPS? How it works?
3. List the different driver assistance systems used in modern automobiles.
4. Explain the method of object recognition and lane detection.

Course Outcome 4 (CO4):

1. List the modern micro-processor control devices used in modern vehicles.
2. What is adaptive head light? How it works?
3. Distinguish between car A/C and climate control system.
4. Explain the working of an ESP with a layout sketch.

Course Outcome 5 (CO5):

1. Explain the principle of operation of a PEM fuel cell
2. What are the characteristics of a high temperature fuel cell?
3. Explain integrated Air supply and humidification concepts for fuel cell systems.
4. Write a note on fuel cell stacks.

Model Question paper**QP CODE:****PAGES:02****Reg. No:** _____**Name :** _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: AUT 382

Course Name: MODERN AUTOMOTIVE TECHNOLOGY

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

(Answer all questions. Each question carry 3 marks)

1. Distinguish between BEVs and PBEVs
2. What are the advantages and disadvantages of a parallel HEV?
3. Explain the direct injection method used for charge stratification.
4. Discuss the principle of operation of a RCCI engine.
5. List the different driver assistance systems used in modern automobiles.
6. What is the principle of object recognition?
7. Distinguish between regular car A/C and a climate control system.
8. Discuss the principle of operation of a wheel speed sensor.
9. What are the advantages of a fuel cell electric vehicle?
10. Give a comparison between PEM and Alkaline Electrolyte fuel cells

(3 x 10 = 30 Marks)**Part B**

Answer any one full question from each module.

Each question carries 14 Marks

11. a. What are the basic factors to be considered for converting automobiles to an electric vehicle? (7)
- b. Distinguish between HEVs and PHEVs with examples. (7)
- OR**
12. a. Discuss the operating modes and Control Strategy for BEVs and HEVs (7)
- b. Distinguish between parallel and series HEVs. (7)
13. (b) a. Explain the terms Swirl, squish and tumble. What is their significance in stratified charge engines? (7)
- b. Explain the different methods used for charge stratification. (7)
- OR**
14. a. Discuss the different combustion modes in a GDI engine. (7)
- b. Explain the concept and working of a Lean burn engine. (7)
15. Explain the capabilities of various navigation systems in modern automobiles (14)
- OR**
16. Explain how the lane recognition and traffic light recognition is done. (14)
17. a. Explain the working a adaptive head light (7)
- b. With the help of a layout sketch, explain the working of a anti-theft system (7)

OR

18. What is GPS and how it works? Discuss the importance of GPS in modern navigation systems. (14)

19. Explain the working of Alkaline Electrolyte fuel cell with a neat sketch (14)

OR

20. Write a brief note on the following:

a. Fuel cell Auxiliary systems. (7)

b. Medium and high temperature fuel cells (7)

(5 x 14 = 70 Marks)

SYLLABUS

Module 1

Electric and Hybrid Vehicle technology: Introduction, LEV, TLEV, ULV & ZEV, Basic components of Electric vehicles- Inverters, Battery packs and battery management system, motors, electronic power control unit, Electric wiring harness – CAN Bus, Multiplex wiring, regenerative braking, basic factors to be considered for converting automobiles to electric vehicle, hybrid electric vehicle, types - series and parallel hybrid, layouts, comparison, Power systems and control systems, Different modes of operation of hybrid vehicles for best performance.

Module 2

Recent Trends in Automotive Power Plants: Stratified charged / lean burn engines – TSI engines, RCCI engines, Hydrogen Engines, Flex fuel vehicles.

Vehicle Operation and engine Control: Application of sensors and actuators and microprocessors for operation of the vehicle to achieve best fuel economy, reduced emission and optimum road performance, Closed loop and open loop operation, electronic engine management systems, Electronic cruise control, chassis control system, Integrated systems.

Module 3

Principle of automobile navigation and controls in the new generation cars- capabilities of navigation and control of modern cars.

Driver Assistance Systems in Automobiles: Vision in cars, A comprehensive driver assistance approach – Lane recognition, Traffic sign recognition, road recognition, Object recognition – Traffic lights and signals

Module 4

Modern electronic and micro control systems in automobiles: Electronically controlled concealed headlight systems, Electro chromic mirrors, automatic review mirrors, Day time running lamps (DRL), Head up display, Travel information systems, On board navigation system, Electronic climate control, Electronically controlled sunroof, Anti-theft systems, Automatic door locks (ADL), tyre pressure sensing, automated wiper, Antilock braking system and, electronic traction and stability control (ESP).

Module 5

Fuel Cells and Alternative energy systems: Introduction to fuel cells, Operational fuel cell voltages, Proton Exchange membrane fuel cells, Alkaline Electrolyte fuel cells, Medium and high temperature fuel cells, fuel and fuel chose, fuel processing, fuel cell stacks, Delivering fuel cell power, Integrated Air supply and humidification concepts for fuel cell systems, Fuel cell Auxiliary systems.

Text Books

1. Barry Hollebeak, Automotive Electricity, Electronics and Computer Controls, Delmer Publishers. 8. Tom Denton, Automotive Electronics, SAE
2. Beranek. L. L., Noise Reduction, McGraw-Hill Book Co., Inc, New York, 1993.
3. Bosch Hand Book, 3rd Edition, SAE, 1993.
4. Bob Brant, Build Your Own Electric Vehicle, McGraw-Hill, 2013.

References

1. SAE, Electric and Hybrid Electric Vehicles and Fuel Cell Technology, SAE.
2. Andrew Dicks and James Laminine, Fuel Cell Systems Explained, SAE.
3. SAE, Fuel cells and alternative fuels / Energy systems
4. SAE, Fuel Cell Power for Transportation, 2001.
5. Rickard Stobart, Fuel Cell Technology for Vehicles, SAE.

Course Contents and Lecture Plan

No.	Topic	No. of Lectures
1	Electric and Hybrid Vehicle technology	
1.1	Introduction, LEV, TLEV, ULV & ZEV, Basic components of Electric vehicles- Inverters	1
1.2	Battery packs and battery management system, motors, electronic power control unit	1
1.3	Electric wiring harness – CAN Bus	1
1.4	Multiplex wiring. regenerative braking	1
1.5	Basic factors to be considered for converting automobiles to electric vehicle	1
1.6	Hybrid electric vehicle	1
1.7	Types - series and parallel hybrid, layouts, comparison	1
1.8	Power systems and control systems	1
1.9	Different modes of operation of hybrid vehicles for best performance.	1
2	Recent Trends in Automotive Power Plants	
2.1	Stratified charged / lean burn engines – TSI engines	1
2.2	RCCI engines, Hydrogen Engines, Flex fuel vehicles	1
2.3	Vehicle Operation and engine Control	1
2.4	Application of sensors and actuators and microprocessors for operation of the vehicle to achieve best fuel economy	1
2.5	Reduced emission and optimum road performance	1
2.6	Closed loop and open loop operation	1
2.7	Electronic engine management systems	1

2.8	Electronic cruise control	
2.9	Chassis control system, Integrated systems.	1
3	Principle of automobile navigation and controls in the new generation cars	
3.1	Capabilities of navigation and control of modern cars.	1
3.2	Application and working of GPS	1
3.3	Driver Assistance Systems in Automobiles	1
3.4	Vision in cars	1
3.5	A comprehensive driver assistance approach	1
3.6	Lane recognition,	1
3.7	Traffic sign recognition,	1
3.8	Road recognition methods	1
3.9	Object recognition – Traffic lights and signals	1
4	Modem electronic and micro control systems in automobiles	
4.1	Electronically controlled concealed headlight systems	1
4.2	Electro chromic mirrors, automatic review mirrors	1
4.3	Day time running lamps (DRL)	1
4.4	Head up display, Travel information systems	1
4.5	On board navigation system, Electronic climate control	1
4.6	Electronically controlled sunroof, Anti-theft systems	1
4.7	Automatic door locks (ADL), tyre pressure sensing	1
4.8	Automated wiper, Antilock braking system	1
4.9	Electronic traction and stability control (ESP)	1
5	Fuel Cells and Alternative energy systems	
5.1	Introduction to fuel cells, Operational fuel cell voltages	1
5.2	Proton Exchange membrane fuel cells,	1
5.3	Alkaline Electrolyte fuel cells	1
5.4	Medium and high temperature fuel cells	1
5.5	Fuel and fuel chose	1
5.6	fuel processing,	1
5.7	fuel cell stacks, Delivering fuel cell power	1
5.8	Integrated Air supply and humidification concepts for fuel cell systems	1
5.9	Fuel cell Auxiliary systems	1

APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

SEMESTER VI

HONOURS



CODE MUT 394	COURSE NAME IC ENGINES AND ADVANCED COMBUSTION STRATEGIES	CATEGORY	L	T	P	CREDIT
		VAC	4	0	0	4

Preamble: This course aims at providing the students, an insight on the advanced combustion systems and engine technologies.

Prerequisite: NIL

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

CO 1	Understand the chemistry of combustion and classification of Engines
CO 2	Understand the differences of combustion in SI and CI Engines
CO 3	Understand the modern SI engine combustion and emission control technologies.
CO 4	Understand the modern CI engine combustion and emission control technologies.
CO 5	Understand the basic principles, types and operation of LTC concepts and strategies.

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	-	1	1	-	-	2	-	1
CO 2	2	1	-	2	-	1	2	-	-	2	-	1
CO 3	-	1	-	1	-	1	1	-	-	2	-	1
CO 4	-	-	-	-	-	1	1	-	-	2	-	1
CO 5	-	1	-	1	-	2	2	-	-	2	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
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 maximum 2 sub-divisions and carry 14 marks.

Expected outcome:

The students will become aware of the latest developments and advancement in the field of IC engines.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. What are the thermodynamic principles of Engines?
2. What are the sub parts/systems of the basic Automotive Engines?
3. Discuss the different types of Automotive Engine materials.
4. What is well to wheel efficiency?
5. What are the classifications of Heat Engines?

Course Outcome 2 (CO2)

1. Explain the factors affecting the SI engine combustion

2. Explain the phases of SI Engine combustion graphically.
3. Discuss about CI Engine combustion and important factors.
4. What is the fuel spray structure in CI Engine combustion?
5. Give a comparison of SI and CI engine in terms of ignition delay.

Course Outcome 3(CO3):

1. Explain the salient features of HCSI engines.
2. Explain the different combustion modes in a GDI engine
3. What is the concept of Hydrogen in Spark-Ignited Engines
4. What are the different factors affecting the HCSI combustion?
5. List out the emission control devices in modern gasoline engines

Course Outcome 4 (CO4):

1. Discuss the working of a CRDI engine.
2. What are the approaches to auto-ignition combustion operation in gasoline engines?
3. Explain the combustion control methods used in auto-ignition combustion operation in gasoline engines.
4. What are the different types of electronic diesel injectors ?
5. Explain the various types of turbochargers and its applications.

Course Outcome 5 (CO5):

1. Explain the principle of operation of a HCCI engine
2. What are the external and internal mixture preparation techniques in LTC engines?
3. What are the combustion control methods used in HCCI engines?
4. What are the features of a RCCI engine?
5. Differentiate between HCCI engine and RCCI engine.

Model Question paper**QP CODE:****PAGES:...****Reg. No:** _____**Name :** _____**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY****SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR****Course Code: MUT 394****Course Name: IC ENGINES AND ADVANCED COMBUSTION STRATEGIES****Max. Marks: 100****Duration: 3 Hours****Part A****(Answer all questions. Each question carries 3 marks)**

1. List the emission control methods used in modern SI engines.
2. What are the functions of two oxygen sensors in the exhaust?
3. Give a comparison of super charger and a turbo charger.
4. What is the principle of operation of dual fuel engines?
5. List the main advantages of LNG vehicles compared to CNG vehicles.
6. Discuss the principle of Lean burn engines.
7. Why TSI engines are superior to usual GDI engines?
8. List the advantages of LTC strategies.
9. What are the methods used to increase the operational range of HCCI engine?
10. List down the fuel properties required for RCCI engines.

Part B**(Answer any one full question from each module. Each question carries 14 Marks)**

11. (a) Explain the working of GDI engine with a suitable lay out. (7)
- (b) Discuss the working of a Lamda sensor. (7)

OR

12. With a suitable sketch explain the working of a CRDI system and emission control strategies (14)
13. Discuss the important factors affecting the performance of a dual fuel engine. (14)

OR

14. With a suitable sketch explain the components and working of a CNG vehicle. (14)

15. Discuss the principle and working of a Lean burn engine (14)

OR

16. Explain any two techniques used for increasing the lean operation limits. (14)

17. Explain the different operational modes of a stratified charge engine? (14)

OR

18. What are the different types of gas turbine combustors? Explain their working in detail. (14)

19. Explain a typical control system employed for four stroke HCCI engines. (14)

OR

20. Give a brief discussion about the concept and working of an RCCI engine. Also give a comparison between HCCI and RCCI engines. (14)

SYLLABUS

MUT 394 IC ENGINES AND ADVANCED COMBUSTION STRATEGIES

Module 1

IC engine Combustion – IC Engine Classifications, Combustion equations, heat of combustion, Theoretical flame temperature, Chemical equilibrium and dissociation, Theories of Combustion, Pre-flame Reactions- Reaction rates - Laminar and Turbulent Flame Propagation in Engines. Construction and working, Engine operating Cycles – Ideal and Fuel Air Cycles, Well to wheel efficiency.

Module 2

SI Engine Combustion – Phases of Ignition, Flame Propagation – Factors, Flame Structure, Burning Velocity, Cycle to Cycle Variations , CI Engine Combustion – Stages of Combustion, Heat Release Rate analysis, Ignition Delay - Factors, Diesel fuel Spray structure, Spray Penetration, Spray Angle, Droplet distribution and Evaporation.

Module 3

Advanced Spark-Ignition Engines – GDI Engines combustion – Homogenous-Charge Spark-Ignition (HCSI) Engines, Equivalence Ratio and Engine Emissions in HCSI engines, Combustion Duration in HCSI Engines, Hydrogen in Spark-Ignited Engines, TSI engines-working, advantages, Emission control devices in modern SI engines

Module 4

Advanced Diesel engines- High pressure CRDI, Components of CRDI system- pump, rail, rail pressure sensor, rail pressure control valve, electronic injectors- types, pulse width, duty cycle,

multiple injection diesel combustion, UPCR, super chargers and turbo chargers-types, components, EGR, emission control devices in modern diesel engines.

Module 5

Low Temperature Combustion Strategies- Types, Principle, advantages, HCCI and CAI engines – fundamentals – external and internal mixture preparation techniques, effect of use of exhaust gas dilution – approaches to CAI/HCCI – Two stroke CAI engines – principles – control – potential applications – four stroke gasoline and diesel HCCI engines – HCCI fuel requirements – low temperature and premixed combustion with late injection – NADI concept of HCCI –CAI control and CAI/SI switching, Concept and working of dual fuel reactivity controlled compression ignition (RCCI) engine.

TextBooks:

1. John B Heywood, “Internal Combustion Engine Fundamentals”, McGraw Hill Education, 2011.
2. VGanesan, *Internal Combustion Engine* Tata McGraw Hill Publishing Company Ltd., New Delhi 2006.
3. HZhao, *Advanced Direct Injection Combustion Engine Technologies and Development*, volume 1-gasoline and gas engines, Wood head publishing, 2009.
4. H Zhao, *Advanced Direct Injection Combustion Engine Technologies and Development*, volume 2-diesel engines, Wood head publishing, 2009

Reference Books

1. H Zhao , *HCCI and CAI Engines for the Automotive Industry*, Woodhead publishing
2. Derek Dunn -Rankin, *Lean Combustion: Technology and Control*, Academic press, 2007
3. M.L. Mathur, R. P. Sharma-*Internal Combustion Engines*, Dhanpat Rai Publications.
4. Richard Stone, *Introduction to internal combustion engines*, The Macmillan press Ltd.
5. H.N.Guptha, *Fundamentals of Internal combustion engines*, PHI learning Pvt Ltd

Course Contents and Lecture Schedule

No	Topics	No. of Lectures
1	MODULE – 1: (9 hours)	
1.1	Combustion - Combustion equations, heat of combustion	2
1.2	Theoretical flame temperature, Chemical equilibrium and dissociation, Theories of Combustion	2
1.3	Pre-flame Reactions- Reaction rates - Laminar and Turbulent Flame Propagation in Engines.	3

1.4	Construction and working, Engine operating Cycles – Ideal and Fuel Air Cycles, Engine Classifications, Well to wheel efficiency	2
2	MODULE – 2: (9 hours)	
2.1	SI Engine Combustion – Phases of Ignition, Flame Propagation – Factors, Flame Structure, Burning Velocity, Cycle to Cycle Variations	3
2.2	CI Engine Combustion – Stages of Combustion, Heat Release Rate analysis, Ignition Delay - Factors	3
2.3	Fuel Spray structure, Spray Penetration, Spray Angle, Droplet distribution and Evaporation	3
3	MODULE – 3: (9 hours)	
3.1	Advanced Spark-Ignition Engines – GDI Engines combustion	2
3.2	Homogenous-Charge Spark-Ignition (HCSI) Engines, Equivalence Ratio and Engine Emissions in HCSI engines, Combustion Duration in HCSI Engines	3
3.3	Hydrogen in Spark-Ignited Engines Through Partial	2
3.4	Emission control devices in modern SI engines	2
4	MODULE – 4: (9 hours)	
4.1	Advanced Diesel engines- High pressure CRDI, Components of CRDI system- pump, rail, rail pressure sensor, rail pressure control valve	2
4.2	Electronic injectors- types, pulse width, duty cycle, multiple injection diesel combustion	2
4.3	UPCR, turbo chargers-types, components, EGR	3
4.4	Emission control devices in modern diesel engines.	2
5	MODULE – 5: (9 hours)	
5.1	Low Temperature Combustion Strategies- Types, Principle	1
5.2	Low Temperature Combustion Strategies- advantages,	1
5.3	HCCI and CAI engines – fundamentals – external and internal mixture preparation techniques,	1
5.4	Effect of use of exhaust gas dilution – approaches to CAI/HCCI	1
5.5	Two stroke CAI engines – principles – control – potential applications	
5.6	Four stroke gasoline and diesel HCCI engines – HCCI fuel requirements	1
5.7	Low temperature and premixed combustion with late injection – NADI concept of HCCI	1
5.8	CAI control and CAI/SI switching	1
5.9	Concept and working of dual fuel reactivity controlled compression ignition (RCCI) engine.	1