Sana'a University
Faculty of Engineering
Mechanical Engineering Department
Mechanical Engineering Program

Course Specification of Internal Combustion Engines

I. Course Identification and General Information:

1.	Course Title:	Internal Combustion Engines.				
2.	Course Code & Number:	ME355.				
3.	Credit Hours:	C.H				TOTAL CR. HRS
		Th.	Seminar/Tu	Pr	Tr.	
		2	2	2	-	4
4.	Study level/ semester at which this course is offered:	Fourth Year - First Semester.				
5.	Pre –requisite (if any):	Thermodynamics – II (ME252).				
6.	Co –requisite (if any):	Heat and Mass Transfer (ME353).				
7.	Program (s) in which the course is offered:	Mechanical Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	Location of teaching the course:	Mechanical Engineering Department.				
10.	Prepared By:	Asst. Prof. Dr. Abduljalil Al-Abidi				
11.	Date of Approval:					

II. Course Description:

This course provides an introduction, classification, and operating characteristics of internal combustion engines (ICE). It includes the studying of concepts and theories of operation of ICE based upon the fundamental engineering sciences of thermodynamics, heat transfer. Difference between thermodynamic ideal cycles and actual cycles are analyzed. Discussing the combustion characteristics of spark-ignition engine, compression-ignition engine and studying the effect of various factors on combustion processes. It covers the engine test and performance in terms of energy utilization and exhaust emissions.

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Asst. Prof. Dr. Abduljalil Al-Abidi	Asst. prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

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III. Alignments of the Course Intended learning outcomes (CILOs)		Referenced PILOs
a1	Recognize the operation, components, classification and operating parameters of internal combustion engines (ICE).	A1
a2	Explain the theoretical and actual cycles, combustion processes of ICE, and performance characteristics.	A2
b1	Analyze the power cycle of ICE using ideal gas cycles and fuel-air cycles.	B1
b2	Investigate thermodynamic efficiencies, engine operating parameters and operating losses.	B2
c1	Conduct experiments related to Internal combustion engine.	C1
c2	Apply systematic methods to performance analysis of ICE based on energy utilization, engine brake power, and exhaust emissions.	C2
d1	Communicate effectively through oral and written modes.	D1
d2	Share ideas and work in a team in an efficient and effective manner under controlled supervision or independently.	D2

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1- Recognize the operation, components, classification and operating parameters of internal combustion engines (ICE).	Lectures, Tutorials Laboratory, Seminars	Examinations, Laboratory Reports, Homework Presentations
a2- Explain the theoretical and actual cycles, combustion processes of ICE, and performance characteristics.	Lectures, Tutorials, Laboratory, Seminars, Projects	Examinations, Laboratory Reports, Homework Presentations, Individual and Group Project Reports.

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(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:			
Course Intended Learning Outcomes		Teaching strategies	Assessment Strategies
b1-	Analyze the power cycle of ICE using ideal gas cycles and fuel-air cycles.	Lectures, Tutorials, Laboratory, Seminars, Projects	Examinations, Homework, Laboratory Reports Presentations, Individual and Group Project Reports
b2-	Investigate thermodynamic efficiencies, engine operating parameters and operating losses.	Lectures, Tutorials, Laboratory, Seminars, Projects	Examinations, Homework, Laboratory Reports Presentations, Individual and Group Project Reports

© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:			
Course Intended Learning Outcomes		Teaching strategies	Assessment Strategies
c1-	Conduct experiments related to Internal combustion engine.	Lectures, Laboratory, Seminars, Projects, Small Group	Examinations, Laboratory Reports, Presentations, Individual and Group Project Reports.
c2-	Apply systematic methods to performance analysis of ICE based on energy utilization, engine brake power, and exhaust emissions.	Lectures, Laboratory, Seminars, Projects, Small Group	Examinations, Laboratory Reports, Presentations, Individual and Group Project Reports.

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(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:			
Course Intended Learning Outcomes		Teaching strategies	Assessment Strategies
d1-	Communicate effectively through oral and written modes.	Laboratory, Seminars, Projects, Small Group	Presentations, Reports
d2-	Share ideas and work in a team in an efficient and effective manner under controlled supervision or independently.	Tutorials, Laboratory, Seminars, Projects, Small Group	Presentations, Reports

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction of ICE, Classification of ICE, Engine Components.	a1	Introduction, ICE Classification, ICE components. Types of Ignition 4 stroke, 2 stroke Comparison of SI and CI Engines	1	2
2.	Operating Characteristics	a1,a2	Engine parameters Work Mean effective pressure Torque and power Air fuel ratio Specific fuel consumption Engine efficiency Volumetric efficiency	1	2

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			Emission		
3.	Theoretical Air Standard Cycles and Their Analysis.	a1,a2,b1,b2, c2 d1,d2	Basic Thermodynamic Processes Carnot cycle Otto Cycle Diesel Cycle Dual cycle Comparisons of Ideal Cycles	2	4
4.	Fuels and Combustion Thermodynamics	a1,a2,b1,b2, c2 d1,d2	Combustion Enthalpy of formation 1st law analysis of steady reaction combustion system	2	4
5.	Fuel-Air Cycles and Their Analyses	a1,a2,b1,b2, c2 d1,d2	Fuel air cycle Factors affecting the fuel –air cycles Effect of engine variables on the performance of Fuel-air cycles	1	2
6.	Mid-Term Exam	a1,a2,b1,b2, c2	The First Four Chapters	1	2
7.	Ice Actual Cycles	a1,a2,b1,b2, c2 d1,d2	Difference between the actual cycle and the Fuel-air cycle (Time losses, Exhaust blow down Heat losses) Effect of engine variables on flame speed Effect of spark-advance on the actual Cycle of S l engines	2	4

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			Power and efficiency of the actual cycle		
8.	Combustion in Spark-Ignition Engines	a1,a2,b1,b2, c2 d1,d2	Normal combustion Combustion in SI engine Factors affecting ignition lag Factors affecting combustion in spark-ignition Engines Abnormal combustion—auto-ignition and Detonation Theories of detonation Effect of engine variables on knock Uncontrolled combustion Octane requirement	1	2
9.	Combustion in Compression-Ignition Engines	a1,a2,b1,b2, c2 d1,d2	Combustion in CI engines rating of fuels, Influence of various factors on delay period Combustion knock in cl engines Comparison of knocking in SI & CI engines Methods of controlling knock in CI engines Combustion chamber for CI engines.	1	2
10.	Fuel Supply and Supercharging	a1,a2,b1,b2, c2 d1,d2	Fuel supply in SI engine Fuel injection in SI engines Fuel injection in CI engines	1	2

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			Supercharging		
11.	Exhaust Emissions & Their Control	a1,a2,b1,b2, c2 d1,d2	Exhaust emissions from SI, CI NOx formation in SI, CI Hydrocarbon and soot emissions Emission control techniques	1	2
12.	Engine Test and Performance	a1,a2,b1,b2, c2 d1,d2	Engine Indicated power Engine Brake Power Engine friction Measuring equipment	1	2
13.	Final Exam	a1,a2,b1,b2, c2	All the Chapters	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B - Practical Aspect:

Order	Tutorial and Experiments	Week Due	Contact Hours	Learning Outcomes
1.	Demonstration of Different Engines.	2	4	b1, b2, c1, c2, d1, d2
2.	I.C engine components.	2	2	b1, b2, c1, c2, d1, d2
3.	Air Intake system, Fuels supply systems (a) Carburetors, (b) Diesel Fuel Injection Systems, (c) Gasoline Fuel Injection Systems.	3, 4	4	b1, b2, c1, c2, d1, d2
4.	Operation IC Engine Systems Engine starting Systems, Ignition systems.	5	2	b1, b2, c1, c2, d1, d2
5.	Operation ICE Engine Systems Engine Cooling & Lubricating Systems.	6	2	b1, b2, c1, c2, d1, d2

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6.	Disassembly and Assembly of Engines.	7	2	b1, b2, c1, c2, d1, d2
7.	Constant Speed Test of a Diesel Engine, Variable Speed Test of a Diesel Engine.	8	2	b1, b2, c1, c2, d1, d2
8.	Constant Speed Test of Gasoline Engine, Variable Speed Test of a SI Engine.	9	2	b1, b2, c1, c2, d1, d2
9.	Study of Power Balance of a 4-Stroke Single Cylinder Diesel Engine.	10	2	b1, b2, c1, c2, d1, d2
10.	Experiment Exhaust emissions & Exhaust Gas Analysis, their Control.	11	2	b1, b2, c1, c2, d1, d2
11.	Performance Test of a 4-Stroke Single Cylinder Diesel Engine.	12	2	b1, b2, c1, c2, d1, d2
12.	Performance Test of a 4-Stroke Single Cylinder Gasoline Engine.	13	2	b1, b2, c1, c2, d1, d2
Number of Weeks /and Units Per Semester		**14**	**28**	

C: Tutorial Aspects:

Order	Units/Topics List	Number of Weeks	Contact Hours	Learning Outcomes
1.	Introduction of ICE, Classification of ICE, Engine Components.	1	2	a1
2.	Operating Characteristics	1	2	a1,a2
3.	Theoretical Air Standard Cycles and Their Analysis.	2	4	a1,a2,b1.b2, c2 d1,d2
4.	Fuels and Combustion Thermodynamics	2	4	a1,a2,b1.b2, c2 d1,d2

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5.	Fuel-Air Cycles and Their Analyses	1	2	a1,a2,b1.b2, c2 d1,d2
6.	Ice Actual Cycles	2	4	a1,a2,b1.b2, c2 d1,d2
7.	Combustion in Spark-Ignition Engines	1	2	a1,a2,b1.b2, c2 d1,d2
8.	Combustion in Compression-Ignition Engines	1	2	a1,a2,b1.b2, c2 d1,d2
9.	Fuel Supply and Supercharging	1	2	a1,a2,b1.b2, c2 d1,d2
10.	Exhaust Emissions & Their Control	1	2	a1,a2,b1.b2, c2 d1,d2
11.	Engine Test and Performance	1	2	a1,a2,b1.b2, c2 d1,d2
Number of Weeks /and Units Per Semester		**14**	**28**	

V. Teaching strategies of the course:

1. Lectures.
2. Tutorials.
3. Laboratory Based Session
4. Team Work (Group Learning)
5. Seminar/ Project/Presentation.
6. Problem Based Learning.
7. Interactive Class Discussions

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	**Homework1:** Classification of ICE, Engine Components.	a1,a2, b1,b2,c1,c2 d1, d2	1st	1

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2.	**Homework2:** Operating Characteristics	a1,a2, b1,b2,c1,c2 d1, d2	2nd	1
3.	**Homework3:** Cycles and Their Analysis.	a1,a2, b1,b2,c1,c2 d1, d2	3rd	1
4.	**Homework4:** Combustion Thermodynamics	a1,a2, b1,b2,c1,c2 d1, d2	4th	1
5.	**Homework5:** Fuel-Air Cycles and Their Analyses	a1,a2, b1,b2,c1,c2 d1, d2	5th	1
6.	**Homework6:** Ice Actual Cycles	a1,a2, b1,b2,c1,c2 d1, d2	6th	1
7.	**Homework7:** Combustion in Spark-Ignition Engines	a1,a2, b1,b2,c1,c2 d1, d2	7th	1
8.	**Homework8:** Combustion in Compression-Ignition Engines	a1,a2, b1,b2,c1,c2 d1, d2	8th	2
9.	**Homework9:** Fuel Supply and Supercharging	a1,a2, b1,b2,c1,c2 d1, d2	9th	2
10.	**Homework10:** Exhaust Emissions & Their Control	a1,a2, b1,b2,c1,c2 d1, d2	10th	2
11.	**Homework11:** Engine Test and Performance	a1,a2, b1,b2,c1,c2 d1, d2	11th	2
Total				**15**

VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Home works	Weekly	15	7.5%	a1,a2, b1,b2,c1,c2 d1, d2
2.	Project (single\group)	13th	15	7.5%	b1,b2,c2 d1, d2
3.	Quizzes	5 th,10th,	20	10%	a1,a2, b1,b2,c2 d1, d2

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4.	Mid-Term Exam	8th	20	10%	a1,a2, b1,b2,c2
5.	Final Exam (practical)	15th	30	15%	b1,b2,c1,c2
6.	Final Exam (theoretical)	16th	100	50%	a1,a2, b1,b2,c2
Total			**200**	**100%**	

VIII. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1- W.W Pulkrabek, 2014, Engineering Fundamentals of Internal Combustion Engines, 2nd Edition. Prentice Hall.
2- H.A. Gupta-2013- Fundamentals of Internal Combustion Engines -2nd Edition- PHI Learning Private Limited.

2- Essential References.

1. R.K. Rajput- 2016- A Textbook of Internal Combustion Engines-3rd Edition- Laxmi Publications.
2. Heywood J.B., 1998, Internal Combustion Engines Fundamentals, 1st Edition- McGraw-Hill, Inc.

3- Electronic Materials and Web Sites *etc*.

1- https://app.knovel.com/web/toc.v/cid:kpICEHBCS1/viewerType:toc/root_slug:internal-combustion-engine-3/url_slug:internal-combustion-engine-3/
2- https://app.knovel.com/web/toc.v/cid:kpAIETD006/viewerType:toc/root_slug:an-introduction-engine/url_slug:an-introduction-engine/

IX. Course Policies:

1. Class Attendance:

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Asst. Prof. Dr. Abduljalil Al-Abidi	Asst. prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

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	-A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic
2.	**Tardy:** - For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent.
3.	**Exam Attendance/Punctuality:** - A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam.
4.	**Assignments & Projects:** - The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
5.	**Cheating**: - For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6.	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university.
7.	**Other policies:** - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. Lecture notes and assignments my given directly to students using soft or hard copy

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Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Asst. Prof. Dr. Eng. Hamoud A. Al-Nahari**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

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Faculty of Engineering
Mechanical Engineering Department
Mechanical Engineering Program

Course Specification of Internal Combustion Engines

I. Information about Faculty Member Responsible for the Course:								
Name of Faculty Member	Asst. Prof. Dr. Abduljalil Al-Abidi	**Office Hours**						
Location& Telephone No.	777704207	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail								

II. Course Identification and General Information:						
1-	Course Title:	Internal Combustion Engines.				
2-	Course Number & Code:	ME355.				
3-	Credit Hours:	C.H				TOTAL CR. HRS
		Th.	Seminar/Tu.	Pr.	Tr.	
		2	2	2	-	4
4-	Study level/year at which this course is offered:	Fourth Year - First Semester.				
5-	Pre –requisite (if any):	Thermodynamics – II (ME252).				
6-	Co –requisite (if any):	Heat and Mass Transfer (ME353).				
7-	Program (s) in which the course is offered	Mechanical Engineering Program.				
8-	Language of teaching the course:	English Language.				
9-	System of Study:	Semesters.				
10-	Mode of delivery:	Lectures, Labs. and Tutorials.				
11-	Location of teaching the course:	Mechanical Engineering Department.				

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III. Course Description:

This course provides an introduction, classification, and operating characteristics of internal combustion engines (ICE). It includes the studying of concepts and theories of operation of ICE based upon the fundamental engineering sciences of thermodynamics, heat transfer. Difference between thermodynamic ideal cycles and actual cycles are analyzed. Discussing the combustion characteristics of spark-ignition engine, compression-ignition engine and studying the effect of various factors on combustion processes. It covers the engine test and performance in terms of energy utilization and exhaust emissions.

IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1. Recognize the operation, components, classification and operating parameters of internal combustion engines (ICE).
2. Explain the theoretical and actual cycles, combustion processes of ICE, and performance characteristics.
3. Analyze the power cycle of ICE using ideal gas cycles and fuel-air cycles.
4. Investigate thermodynamic efficiencies, engine operating parameters and operating losses.
5. Conduct experiments related to internal combustion engine.
6. Apply systematic methods to performance analysis of ICE based on energy utilization, engine brake power, and exhaust emissions.
7. Communicate effectively through oral and written modes.
8. Share ideas and work in a team in an efficient and effective manner under controlled supervision or independently.

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V. Course Content:

- Distribution of Semester Weekly Plan Of course Topics/Items and Activities.

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Week Due	Contact Hours
1.	Introduction of ICE, Classification of ICE, Engine Components.	Introduction, ICE Classification, ICE components. Types of Ignition 4 stroke, 2 stroke Comparison of SI and CI Engines	1st	2
2.	Operating Characteristics	Engine parameters Work Mean effective pressure Torque and power Air fuel ratio Specific fuel consumption Engine efficiency Volumetric efficiency Emission	2nd	2
3.	Theoretical Air Standard Cycles and Their Analysis.	Basic Thermodynamic Processes Carnot cycle Otto Cycle Diesel Cycle Dual cycle Comparisons of Ideal Cycles	3rd, 4th	4
4.	Fuels and Combustion Thermodynamics	Combustion Enthalpy of formation	5th, 6th	4

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		1st law analysis of steady reaction combustion system		
5.	Fuel-Air Cycles and Their Analyses	Fuel air cycle Factors affecting the fuel –air cycles Effect of engine variables on the performance of Fuel-air cycles	7th	2
6.	Mid-Term Exam	The First Four Chapters	8th	2
7.	Ice Actual Cycles	Difference between the actual cycle and the Fuel-air cycle (Time losses, Exhaust blow down Heat losses) Effect of engine variables on flame speed Effect of spark-advance on the actual Cycle of S l engines Power and efficiency of the actual cycle	9th, 10th	4
8.	Combustion in Spark-Ignition Engines	Normal combustion Combustion in SI engine Factors affecting ignition lag Factors affecting combustion in spark-ignition Engines Abnormal combustion—auto-ignition and Detonation Theories of detonation Effect of engine variables on knock Uncontrolled combustion Octane requirement	11th	2
9.	Combustion in Compression-Ignition Engines	Combustion in CI engines rating of fuels, Influence of various factors on delay period Combustion knock in cl engines	12th	2

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		Comparison of knocking in SI & CI engines Methods of controlling knock in CI engines Combustion chamber for CI engines.		
10.	Fuel Supply and Supercharging	Fuel supply in SI engine Fuel injection in SI engines Fuel injection in CI engines Supercharging	13th	2
11.	Exhaust Emissions & Their Control	Exhaust emissions from SI, CI NOx formation in SI, CI Hydrocarbon and soot emissions Emission control techniques	14th	2
12.	Engine Test and Performance	Engine Indicated power Engine Brake Power Engine friction Measuring equipment	15th	2
13.	Final Exam	All the Chapters	16th	2
Number of Weeks /and Units Per Semester			**16**	**32**

B - Practical Aspect:

Order	Tutorial and Experiments	Week Due	Contact Hours	Learning Outcomes
1.	Demonstration of Different Engines.	1st ,2nd	2	b1, b2, c1, c2, d1, d2
2.	I.C engine components.	3nd	2	b1, b2, c1, c2, d1, d2
3.	Air Intake system, Fuels supply systems (a) Carburetors, (b) Diesel Fuel Injection Systems, (c) Gasoline Fuel Injection Systems.	4rd, 5th	4	b1, b2, c1, c2, d1, d2

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4.	Operation IC Engine Systems Engine starting Systems, Ignition systems.	6th	2	b1, b2, c1, c2, d1, d2
5.	Operation ICE Engine Systems Engine Cooling & Lubricating Systems.	7th	2	b1, b2, c1, c2, d1, d2
6.	Disassembly and Assembly of Engines.	8th	2	b1, b2, c1, c2, d1, d2
7.	Constant Speed Test of a Diesel Engine, Variable Speed Test of a Diesel Engine.	9th	2	b1, b2, c1, c2, d1, d2
8.	Constant Speed Test of Gasoline Engine, Variable Speed Test of a SI Engine.	10th	2	b1, b2, c1, c2, d1, d2
9.	Study of Power Balance of a 4-Stroke Single Cylinder Diesel Engine.	11th	2	b1, b2, c1, c2, d1, d2
10.	Experiment Exhaust emissions & Exhaust Gas Analysis, their Control.	12th	2	b1, b2, c1, c2, d1, d2
11.	Performance Test of a 4-Stroke Single Cylinder Diesel Engine.	13th	2	b1, b2, c1, c2, d1, d2
12.	Performance Test of a 4-Stroke Single Cylinder Gasoline Engine.	14th	2	b1, b2, c1, c2, d1, d2
Number of Weeks /and Units Per Semester		**14**	**28**	

C – Tutorial Aspect:

Order	Units/Topics List	Sub Topics List	Week Due	Contact Hours
1.	Introduction of ICE, Classification of ICE, Engine Components.	Introduction, ICE Classification, ICE components. Types of Ignition 4 stroke, 2 stroke Comparison of SI and CI Engines	1st	2

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2.	Operating Characteristics	Engine parameters Work Mean effective pressure Torque and power Air fuel ratio Specific fuel consumption Engine efficiency Volumetric efficiency Emission	2nd	2
3.	Theoretical Air Standard Cycles and Their Analysis.	Basic Thermodynamic Processes Carnot cycle Otto Cycle Diesel Cycle Dual cycle Comparisons of Ideal Cycles	3rd, 4th	4
4.	Fuels and Combustion Thermodynamics	Combustion Enthalpy of formation 1st law analysis of steady reaction combustion system	5 th, 6 th	4
5.	Fuel-Air Cycles and Their Analyses	Fuel air cycle Factors affecting the fuel –air cycles Effect of engine variables on the performance of Fuel-air cycles	7 th	2
6.	Ice Actual Cycles	Difference between the actual cycle and the Fuel-air cycle (Time losses, Exhaust blow down Heat losses) Effect of engine variables on flame speed Effect of spark-advance on the actual Cycle of S l engines Power and efficiency of the actual cycle	8 th, 9 th	4
7.	Combustion in	Normal combustion	10 th	2

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	Spark-Ignition Engines	Combustion in SI engine Factors affecting ignition lag Factors affecting combustion in spark-ignition Engines Abnormal combustion—auto-ignition and Detonation Theories of detonation Effect of engine variables on knock Uncontrolled combustion Octane requirement		
8.	Combustion in Compression-Ignition Engines	Combustion in CI engines rating of fuels, Influence of various factors on delay period Combustion knock in cl engines Comparison of knocking in SI & CI engines Methods of controlling knock in CI engines Combustion chamber for CI engines.	11 th	2
9.	Fuel Supply and Supercharging	Fuel supply in SI engine Fuel injection in SI engines Fuel injection in CI engines Supercharging	12 th	2
10.	Exhaust Emissions & Their Control	Exhaust emissions from SI, CI NOx formation in SI, CI Hydrocarbon and soot emissions Emission control techniques	13 th	2
11.	Engine Test and Performance	Engine Indicated power Engine Brake Power Engine friction Measuring equipment	14 th	2
Number of Weeks /and Units Per Semester			**14**	**28**

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VI. Teaching strategies of the course:

1. Lectures.
2. Tutorials.
3. Laboratory Based Session
4. Team Work (Group Learning)
5. Seminar/ Project/Presentation.
6. Problem Based Learning.
7. Interactive Class Discussions.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Homework 1	a1,a2, b1,b2,c1,c2 d1, d2	1	1
2.	Homework 2	a1,a2, b1,b2,c1,c2 d1, d2	2	1
3.	Homework 3	a1,a2, b1,b2,c1,c2 d1, d2	3	1
4.	Homework 4	a1,a2, b1,b2,c1,c2 d1, d2	4	1
5.	Homework 5	a1,a2, b1,b2,c1,c2 d1, d2	5	1
6.	Homework 6	a1,a2, b1,b2,c1,c2 d1, d2	6	1
7.	Homework 7	a1,a2, b1,b2,c1,c2 d1, d2	7	1
8.	Homework 8	a1,a2, b1,b2,c1,c2 d1, d2	8	1
9.	Homework 9	a1,a2, b1,b2,c1,c2 d1, d2	9	1
10.	Homework 10	a1,a2, b1,b2,c1,c2 d1, d2	10	1
11.	Homework 11	a1,a2, b1,b2,c1,c2 d1, d2	11	1

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12.	Homework 12	a1,a2, b1,b2,c1,c2 d1, d2	12	1
13.	Reports	a1,a2, b1,b2,c1,c2 d1, d2	13	3
Total				**15**

VIII. Schedule of Assessment Tasks for Students During the Semester:

Assessment	Type of Assessment Tasks	Week Due	Mark	Proportion of Final Assessment
1.	Exercises, Report and Home works	Weekly	15	7.5%
2.	Project (single\group)	13 th	15	7.5%
3.	Quizzes	5th ,10th	20	10%
4.	Mid-Term Exam	8 th	20	10%
5.	Final Exam (practical)	15 th	30	15%
6.	Final Exam (theoretical)	16 th	100	50%
Total			**200**	**100%**

IX. Learning Resources:

- *Written in the following order: (Author – Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1- W. W Pulkrabek, 2014, Engineering Fundamentals of Internal Combustion Engines, 2nd Edition. Prentice Hall.

2- H.A. Gupta, 2013-, Fundamentals of Internal Combustion Engines -2nd Edition- PHI Learning Private Limited.

2- Essential References.

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1. R.K. Rajput, 2016-, A Textbook of Internal Combustion Engines-3rd Edition- Laxmi Publications. 2. Heywood J.B.-1998-Internal Combustion Engines Fundamentals, 1st Edition- McGraw-Hill, Inc
3- Electronic Materials and Web Sites *etc*.
1- https://app.knovel.com/web/toc.v/cid:kpICEHBCS1/viewerType:toc/root_slug:internal-combustion-engine-3/url_slug:internal-combustion-engine-3/ 2- https://app.knovel.com/web/toc.v/cid:kpAIETD006/viewerType:toc/root_slug:an-introduction-engine/url_slug:an-introduction-engine/

X. Course Policies:

1.	**Class Attendance:** -A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic
2.	**Tardy:** - For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent.
3.	**Exam Attendance/Punctuality:** - A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam.
4.	**Assignments & Projects:** - The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
5.	**Cheating**: - For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.

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6.	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university.
7.	**Other policies:** - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. Lecture notes and assignments my given directly to students using soft or hard copy

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