Indian Institute of Technology Kanpur

Proposal for a New Course

1. Course No: ME7XXX
2. Course Title: Engine Design
3. **Per Week Lectures: 2 (**L) of 90 minutes duration, Tutorial: 0 (T), Laboratory: 0 (P), Additional Hours [0-2]: 0(A) Credits (2 x L+0 x T+P + A): 2-0-0-9, or 9 credits
4. **Course Duration:** Full semester
5. Grading Policy:

Attendance:	10%
Mid Semester Examination:	30%
End Semester Examination:	45%
Assignment (Three):	15%

- Grading will be relative. However, a minimum of absolute performance would be necessary for a passing grade. Attendance will be used for deciding the borderline cases.
- Students failing to maintain less than 75% attendance will be deregistered from the course.

6. **Proposing Department/IDP**: Mechanical Engineering, Other Dept may be interested in proposing this course: Mechanical Engineering, Aerospace, Manufacturing Engineering
7. Other Faculty members interested in teaching this course: Not applicable
8. **Proposing Instructors**: Prof. Avinash Kumar Agarwal and P. A. Lakshminarayanan
9. Course Description and details:

A. Course Objectives

The following design and its aspect are dealt in detail: Air flow design and its management –

Interaction of air flow and fuel considering mixing to enable least polluting combustion for high efficiency - Charging for enhancing power and emissions– Considering static and dynamic loading for design of critical parts like piston, connecting rod, crankshaft, flywheel, bearings, valves -Dealing with noise aspects by understanding physics of noise and vibration - Cooling layout to run the metallic parts safely – Treatment of emissions in the exhaust including blowby for the latest standards. At the end of the course, the engineer can easily gel seamlessly with a design group in an industry and contribute to designing parts and solving problems.

Expected learning outcomes for this course.

By the end of the course, the students will be industry-ready to design/upgrade/solve problems related to diesel/gasoline/CNG engine by joining a group. It will also help him if he picks up relevant software models to master engine design.

B. Course Content

Lesson	Topic	Lectures of 90 min. duration
1.	Diesel and Gasoline Combustion, physics, chemistry and models for combustion.	2
2.	Matching Fuel Injection Equipment to a diesel engine	3
3.	Liner, Piston, Rings, Gaskets for taking the thermal and mechanical loads and sealing the pressures.	4
4.	Ports – Streamlined and compact ports to produce necessary swirl in case of inlet port and high throughflow in case of inlet and exhaust ports – measurement and design for targeted swirl and flow coefficients	
5.	Cylinder Head – consideration of loads and cooling, accommodating ports, cooling passages, injectors/spark plugs	
6.	Crankcase, Bearing Cap – mother of engine build, discussion on the load bearing structure, testing for strength and bearing cap as a beam	1
7.	Connecting Rod – whipping load, buckling load and tension of the eyes at the big and small ends – clamping the big end by critical fasteners.	1
8.	Crankshaft – as a beam under bending load in fatigue, application of Lloyds method for checking factor of safety, torsional vibration and designing for	1

	torsional strength, Torsional vibration dampers to reduce torsional dynamic stress to safe levels	
9.	Critical Fasteners for clamping cylinder head, big end of connecting rods, bearing caps, selection and design for fatigue loading	1
10.	Valve Train and Cam shape – sizing, design of valves, design of cams	1
11.	Engine Bearings - pressure to support the loads of connecting rods, crankshaft etc.	1
12.	Coolants and Cooling – choice of coolants, cooling system design, rules for optimum temperature difference across engine and radiator	1
13.	EGR Layout -high pressure EGR, EGR valve and control	2
14.	SCR Layout – Chemistry of SCR, Catalysts and calibration	2
15.	NVH related to Engines and Vehicles – noise sources, abatement, some standards	2
16.	Matching a turbocharger to a diesel engine – paper and pencil calculations to to match the rotating machine with the reciprocating engine considering thermodynamics and mechanical limits	2
17.	Breather and Blowby; Flywheel – design of blowby systems to strip the gases of oil and remove soot before letting them safely in the inlet	1
18.	Front End Accessory Drive (FEAD) System – Design of belt drive for water pump, alternator and compressors	2
19.	WLTP and Real Driving Emissions (RDE)* Discussion on the methods	2
	TOTAL	29

- *optional*

Pre-requisites

Prerequisites: Knowledge of undergraduate-level IC engines/ Energy conversion and basic thermodynamics, Design of Machine Elements

C. Short Summary for including in the Courses of Study Booklet

Flow design, Fuel injection Design, Engine management, Design of power train hardware, Emission

treatment.

D. Recommended Books/Textbooks

1. Der Aufbau der raschlaufenden Verbrennungskraftmaschine 1964, Springer Berlin Heidelberg (The Design of High-Speed Internal Combustion Engines for Motor Vehicles and), H. Kremser, 1942
2. Hoag, Kevin, and Brian Dondlinger. Vehicular engine design. Springer, 2015.
3. Mettig, Hermann. Die Konstruktion schnellaufender Verbrennungsmotoren. Walter de Gruyter GmbH & Co KG, 2019.
4. Nestorides, E. J., ed. A handbook on torsional vibrations. Cambridge University Press, 1958.
5. Lakshminarayanan, P. A., and Avinash Kumar Agarwal, eds. Design and development of heavy-duty diesel engines: a handbook. Springer Nature, 2019.
6. VDI 2230 Systematic Calculation of High Duty Bolted Joints 2009
7. Supercharging of Internal Combustion Engines Fundamentals, Calculations, Examples by K. Zinner, Springer

Suggested readings

1. SAE Papers by Wellworthy/Mahle/Nural/Goetze on Pistons, Rings and Pins
2. Online notes by Garrett/BorgWarner on Turbocharging
3. Das Triebwerk schnellaufender Verbrennungskraftmaschinen (The Engine Mechanism of High-Speed Internal Combustion Engines), Hans Kremser, 1949
4. Wärmeübergang in der Verbrennungskraftmaschine (Heat Transfer in the Internal Combustion Engine), W. PflaumK. Mollenhauer, 1977
5. Ortsfeste Dieselmotoren und Schiffsdieselmotoren (Stationary Diesel Engines and Marine Diesel Engines), Fritz Mayr, 1960
6. Gemischbildung und Verbrennung im Ottomotor (Mixture Formation and Combustion in the Spark-Ignition Engine), Kurt LöhnerHerbert Müller, 1967
7. Der Aufbau der raschlaufenden Verbrennungskraftmaschine (The Construction of the High-Speed Internal Combustion Engine), Andreas Scheiterlein, 1964

8. Lager und Schmierung (Bearings and Lubrication)., Kurt Milowiz, 1962
9. Die Gaserzeuger (Gas Producers), Kurt Schmidt, 1959
10. Die Gasmaschine (The Gas Engine), Max Leiker, 1953
11. Verschleiß, Betriebszahlen und Wirtschaftlichkeit von Verbrennungskraftmaschinen (Wear, Operating Data, and Economic Efficiency of Internal Combustion Engines), Carl Englisch, 1952
12. Der Ladungswechsel der Verbrennungskraftmaschine, Dritter Teil: Der Viertakt Ausnützung der Abgasenergie für den Ladungswechsel (The Gas Exchange Process in the Internal Combustion Engine, Part Three: The Four-Stroke Cycle—Utilization of Exhaust Gas Energy for Gas Exchange), Hans List, 1952
13. Der Ladungswechsel der Verbrennungskraftmaschine, Zweiter Teil (The Gas Exchange Process in the Internal Combustion Engine, Part Two: The Two-Stroke Cycle), Der Zweitakt,Hans List, 1950
14. Der Ladungswechsel der Verbrennungskraftmaschine, Erster Teil, Grundlagen Die rechnerische Behandlung der instationären Strömungsvorgänge am Motor (The Gas Exchange Process in the Internal Combustion Engine, Part One, Fundamentals: The Analytical Treatment of Unsteady Flow Processes in Engines), Hans ListGaston Reyl, 1949
15. Die Steuerung der Verbrennungskraftmaschinen (Engine Control Systems), Anton Pischinger, 1948
16. Ortsfeste und Schiffsdieselmotoren (Stationary and Marine Diesel Engines), F. Mayr, 1948
17. Die Dynamik der Verbrennungskraftmaschine (The Dynamics of Internal Combustion Engines), Hans Schrön, 1947
18. Die Dynamik der Verbrennungskraftmaschine (The Dynamics of Internal Combustion Engines, Hans Schrön), Hans Schron, 1942
19. Das Triebwerk schnellaufender Verbrennungskraftmaschinen (The Crank Mechanism of High-Speed Internal Combustion Engines)., Adolf Schnürle,1939,
20. Gemischbildung und Verbrennung im Dieselmotor (Mixture Formation and Combustion in the Diesel Engine), Anton PischingerOtto Cordier,1939

21. Thermodynamik der Verbrennungskraftmaschine (Thermodynamics of the Internal Combustion Engine). Hans List,1939

22. Gemischbildung bei Ottomotoren (Mixture Formation in Spark-Ignition Engines), Hans P. Lenz, 1990,

23. Lagerung und Schmierung von Verbrennungsmotoren (Bearings and Lubrication of Internal Combustion Engines), Josef AffenzellerHeinz Gläser,1996,

24. Kräfte, Momente und deren Ausgleich in der Verbrennungskraftmaschine (Forces, Moments, and Their Balancing in the Internal Combustion Engine), H. MaassH. Klier,1981,

25. Gestaltung und Hauptabmessungen der Verbrennungskraftmaschine (Design and Main Dimensions of the Internal Combustion Engine), H. Maass,1979

26. Schadstoffreduzierung und Kraftstoffverbrauch von Pkw-Verbrennungsmotoren (Pollutant Reduction and Fuel Consumption of Passenger Car Internal Combustion Engines), Fred SchäferRichard van Basshuysen,1993,

27. Theorie der Triebwerksschwingungen der Verbrennungskraftmaschine (Theory of Drivetrain Vibrations in the Internal Combustion Engine), K.E. HafnerH. Maass,1984

E. Any Other Remarks: nil

Date: 14-Mar-26	P. A. Lakshminarayanan Avinash Kumar Agarwal
Date:	DUGC/DPGC Convernor

The course is approved.

Chairman SUGC/SPGC

Date: