Notes:

Lecture 1: Introduction to ICE

Vocabulary

Engine: Device to convert fuel energy to mechanical energy

- Fuel energy to thermal energy by combustion
- Thermal energy to mechanical energy by expansion

Internal combustion: combustion takes place in working fluid
External combustion: combustion occurs externally; energy coupled to working fluid by heat transfer device
Open cycle: working fluid discharged to atmosphere; e.g. all ICE
Close cycle: working fluid recycled through engine; e.g. steam engine with condenser

ICE

Size: displacement volume 1cc to 1m^3 per cylinder; comment on why it is difficult to build engine outside this range.
Power: 10 W to 10^8 W per cylinder
Applications: Automotive, marine, power generation, mechanical devices
Classification:

- by application: Car, Truck, Marine, Rail, Stationary generation, …
- by basic engine design: reciprocating, rotary, in-line block, V-block, radial, oppose piston, pre-/open chamber
- by working cycle: 2-stroke, 4-stroke, naturally aspirated , turbo-charged, super-charged, turbo-compound
- by fuel: gasoline, diesel, alcohol, natural gas, …
- by mixture preparation: carbureted, fuel injection
- by ignition: spark ignited, compression ignited

History

Circa	Event	People and key concept
1860	Rudimentary ICE	Jean J. Lenoir. — Key concept: Combustion increases temperature and gas expands. Expanding gas drives piston to produce mechanical energy. — Modified steam energy; no compression — Operated at 10 cycles/min; efficiency <5% because of low effective compression ratio Sold 500 of them
1867	Atmospheric free piston engine	Nicolaus Otto and Eugene Langen — Key concept: still no compression, but use the inertia of a heavy piston to over-expand the combustion gas to below atmosphere, thereby increasing the expansion ratio. Output mechanical work stored as gravitational potential energy in heavy piston first, and then extracted by clutching piston to fly wheel on downward stroke. — Larger expansion ratio: efficiency increased to 11% — Operate at 28 cycles/minute — Used a flame ignitor through a sliding window Sold 5000, dominated market for 10 years until introduction of the 4-stroke engine
1876	4-stroke engine	Nicolaus Otto
1878	2-stroke engine	Dougald Clerk
1892	Compression Ignition 4-stroke	Rudolf Diesel — Key concepts: prevent the very rapid and high pressure heat