Chapter 8: Engine Design Parameters

8.1: Basic decisions

1. Reasons for new design

2. Type of service

3. Engine type (power and fuel economy requirements)

- Diesel or Petrol
  - Important to decide engine size
  - Engine type
    - Petrol (SIE)
      - Bore < 150 mm
      - Low use factor
    - Diesel
      - Bore > 150 mm
      - Bore < 150 mm & better economy needed
      - High use factor

Note: Low use factor is related to uncritical fuel economy

2 Stroke or 4 Stroke

Engine → 2 Strokes → SIE : Small
- motor-cycle
- Small motor Boats
- Chain saws

Gives : • low first-cost
• low use factor
• low $\frac{W}{P}$ ratio
• only 3 moving parts

with irregular idling ← light-load, and high oil consumption

Disadvantages : 25% less fuel economy

→ CIE : Used for larger Cylinders
- Thermal stresses are less
- Cylinder pressure is less than 4-Stick
- Poorer fuel economy

Supercharging or not

Engine type

→ SIE : Compromise with efficiency

Cases:

1. Air craft :
   - provides High specific output for take-off
   - Compensates for low Pa
   - High octane fuel is used → To solve detonation

2. Racing cars :
   - provides High specific output
   - Special fuel type of fuel is used → To solve detonation

3. Large Natural Gas engines
   - Saves weight and bulk
   - Special fuel type of fuel is used → To solve detonation
   - Engines rated higher than 500 hp are supercharged

→ CIE :
- Used to reduce weight and size
- The larger the engine is, the cheaper the design

Number and arrangement of cylinder

HP

Rated Power	No. of Cyl.	Cyl. Arrangement
0 – 3	1	I
3 – 30	1 – 4	I, O, V
30 – 50	4 – 6	I, O, V
50 – 100	4 – 8	I, O, V
100 – 200	6 – 8	I, O, V
Over 200	6 – 16	I, O, V, R, OP
Over 2000	12 – 24	I, V, R, OP

I = in line vertical or horizontal
O = opposed cylinders
V = V arrangement
R = radial
OP = opposed piston (2 cycle)

Strike

Cylinder arrangements

1- In line engines
- 2 or more cylinders
- Good balance and vibration
- Not light weight- Nor compact but has mechanical simplicity with easy maintenance

2- V- engines
- 8 cylinders or more
- Excellent balance with freedom from vibrational problems
- Compact, high specific output and low cost

3- Opposed Cylinder engine → motor cycles, Rear engine automobiles, Light- airplanes
- Suitable for air cooling
- Used for light- weight- and short- length

4. Radial engines → Aircrafts
   - Convenient shape
   - Lowest weight per unit displacement

5. Opposed piston engine → large marine engines, Locomotive engines, military engines
   - 2 cycle diesel engines
   - Heat losses are reduced
   - Two crank shafts geared together are required (Disadvantage)

8.2: Basic preformance Factors

Select numerical values of main characteristics:

- Mean effective pressure

For Diesel engines

Four Stroke engines	
Unsupercharge	I m.e.p = 6 – 8 bar
Supercharged	I m.e.p = 9 – 12 bar
Two stroke engines	
• Uniflow scavenging	
Unsupercharged	I m.e.p = 5.5 - 8.5 bar
Supercharged	I m.e.p = 9 - 16 bar
• Loop scavenging	
Unsupercharged	I m.e.p = 5 – 8 bar
Supercharged	I m.e.p - 8 – 14 bar
Spark ignition engine	I m.e.p = 6 – 12 bar

Mean piston speed

$$V_p = 2\frac{NL}{60} \text{ m/s}$$

N → RPM, L → Stroke

Low speed engines	N = 100 - 300 rpm	4 – 6 m/s
Medium-speed engines	N = 300 - 1000 rpm	4 - 9 m/s
High speed SIE engines	N > 1000	9 – 15 m/s
High speed CIE engines	N > 1000	9 – 15 m/s

Stroke – bore ratio L/D

– In high speed engines, the ratio should be minimized → To reduce piston speed and increase force acting on piston

Low speed engines	1.2 - 2
Medium speed	1 - 1.5
Petrol & high speed engines	0.7 - 1.2
✗ Compressors	0.6 - 1.8
✗ Pumps	1.5 - 3