**Relationships Between Engine Design and Operating Parameters**

Express **displacement volume** in terms of engine geometry (bore, stroke, and number of cylinders):

Write **three short equations for brake power output**:

1. In terms of the arbitrary efficiency, mass flow rate of fuel, and heating value of fuel
2. In terms of torque and engine speed
3. In terms of bmep, displacement, engine speed, and number of revolutions/power stroke

Write **two short equations of engine torque**:

1. In terms of bmep, displacement, and number of revolutions/power stroke
2. In terms of brake power output and engine speed

Write **three equations for brake specific fuel consumption**:

1. In terms of mass flow rate of fuel and brake power output
2. In terms of the mechanical efficiency, indicated thermal efficiency, combustion efficiency,  
   and heating value of fuel
3. In terms of the arbitrary efficiency and heating value of fuel

Write a **long equation for brake power output** in terms of mechanical efficiency, indicated thermal efficiency, combustion efficiency, heating value of the fuel, fuel/air ratio, volumetric efficiency, intake pressure, intake temperature, bore, stroke, number of cylinders, number of revolutions/power stroke, and engine speed:

Write an **equation for mean piston speed** in terms of stroke and engine speed:

Write **two equations for bmep**:

1. In terms of mechanical efficiency and imep
2. In terms of imep and fmep