Relationships Between Engine Design and Operating Parameters

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

$$V_d = \frac{\pi B^2 L n_c}{4}$$

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

$$P_b = \dot{m}_f \, \eta_f \, Q_{HV}$$

2) In terms of torque and engine speed

$$P_b = T\omega = T \, 2\pi N$$

3) In terms of bmep, displacement, engine speed, and number of revolutions/power stroke

$$P_b = 2\pi N \left(\frac{bmep \, V_d}{2\pi n_R} \right) \quad OR \quad \frac{bmep \, V_d \, N}{n_R}$$

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

1) In terms of bmep, displacement, and number of revolutions/power stroke

$$T = \frac{bmep \, V_d}{2\pi n_R}$$

2) In terms of brake power output and engine speed

$$T = \frac{P_b}{2\pi N}$$

Write **three equations** for <u>brake specific fuel consumption</u>:

1) In terms of mass flow rate of fuel and brake power output

$$BSFC = \dot{m}_f / P_b$$

2) In terms of the mechanical efficiency, indicated thermal efficiency, combustion efficiency, and heating value of fuel

$$BSFC = \dot{m}_f / \left(\eta_f \dot{m}_f Q_{HV} \right) = \frac{1}{\eta_f Q_{HV}} = \frac{1}{\eta_m \eta_t \eta_c Q_{HV}}$$

3) In terms of the arbitrary efficiency and heating value of fuel

$$BSFC = \frac{1}{\eta_f Q_{HV}}$$

Write a **long equation** for <u>brake power output</u> 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:

$$P_b = \eta_m \left[\eta_t \eta_c Q_{HV} \frac{F}{A} \right] \left[\frac{\eta_v P_i}{R T_i} \right] \left[\frac{\pi B^2 L n_c N}{4 n_R} \right]$$

Write an **equation** for <u>mean piston speed</u> in terms of stroke and engine speed:

$$S_p = 2 L N$$

Write **two equations** for <u>bmep</u>:

1) In terms of mechanical efficiency and imep

$$bmep = \eta_m \, imep$$

2) In terms of imep and fmep

$$bmep = imep - fmep$$