# Indian Institute of Technology Kharagpur

End Semester Examination Time: 3 hours Full Marks: 60

Sub: Internal Combustion Engine, ME60111

1. a) What are the different parts of Common Rail Direct Injection? Explain its principle with schematic diagram. [5]

b) Draw the heat release versus crank angle curve of a direct injection diesel engine and explain the different stages of combustion. [4]

c) What causes knock in a CI engine? In which part of the combustion process does it occur? How does this compare with the moment of knocking in a SI engine combustion process? [4]

2. A hydrocarbon fuel of composition 84.1 percent by mass *C* and 15.9 percent by mass *H* has a molecular weight of 114.15. Determine the number of moles of air required and A/F ratio for stoichiometric combustion. (Assume fuel composition $C_aH_b$, a and b are integers) [5]

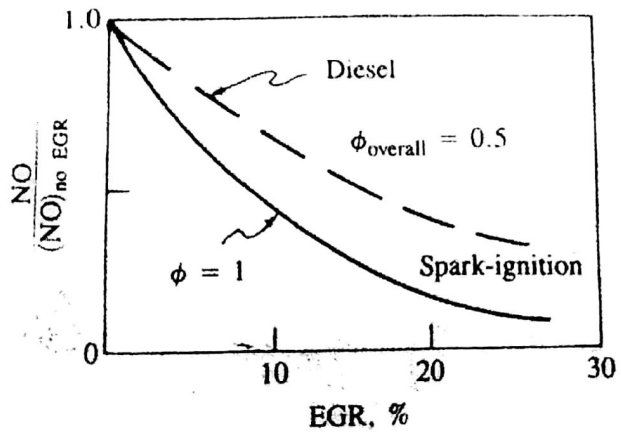
3. a) What are regulated and un-regulated emissions? What are the sources of hydrocarbon emissions and oxidation mechanism within the cylinder and exhaust system for a spark-ignition engine. [6]

b) Explain the principle with a schematic diagram of HC emissions measurement device. [5]

4. Explain the following emissions trends.

a) Draw the exhaust concentrations curve of NO, CO, and HC for a spark-ignition engine and a direct-injection diesel engine versus equivalence ratio. Explain the trends as the mixture is first made richer and then leaner than stoichiometric. [3]

b) Exhaust gas recirculation is used to control the nitric oxide emission. Exhaust gas recirculation is usually more effective with spark-ignition engines than with diesels, as shown in figure below. Explain why these trends are different. [3]



c) Brake specific particulate emissions from diesel engines are a major problem. Particulate emissions from a conventional spark –ignition engines are negligible. Briefly explain why the particulate emissions levels from these two types of engines are so different in magnitude. [3]

d) Diesels have low carbon monoxide (CO) emissions. Spark-ignition engine CO emissions when averaged over a typical urban automobile trip are substantial and require a catalyst for effective control. Explain this difference in average CO emissions from these two types of engine. [3]

5. a) Define valve event. Draw the valve profiles for a conventional IC engine versus crank angle. [3]

b) How you can experimentally measure the valve profile with respect to the crank angle? [4]

c) How can improve the volumetric efficiency of a spark-ignition engine? [3]

d) What is the concept of a camless engine? What are the advantages and disadvantages of Camless engine? [3]

e) What should the timing of intake valve opening (IVO), intake valve closing (IVC), exhaust valve opening (EVO), and exhaust valve closing (EVC) according to the engine operating condition. [6]