3. I.C.E. vibrations

a) b)

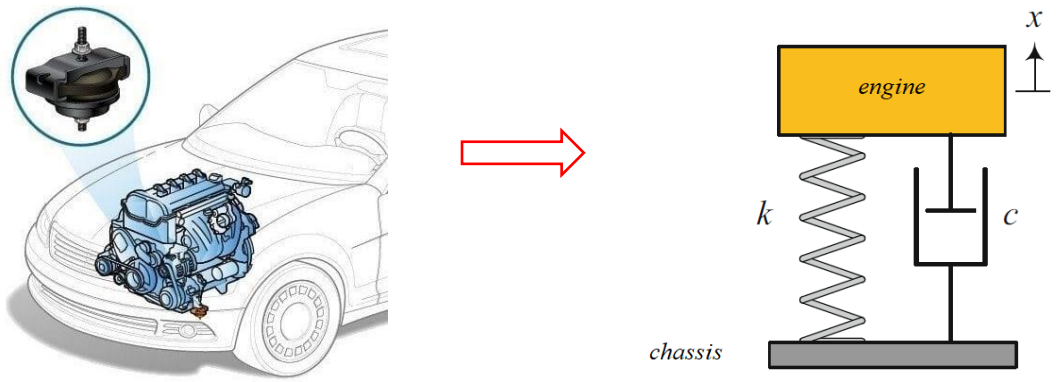

Fig. 3

Consider an in-line 4 cylinder (L4) internal combustion engine. The engine is not equipped with balance shafts. Vibration forces originating from the engine are transmitted from the mounts to the chassis.

Consider two situations:

i) Test 1. Constant angular velocity (idle);

ii) Test 2. Speed ramp from n_1 (lower than idle or zero) to n_2 (max regime).

Consider the following simplifications of the physical model:

- The engine block can oscillate vertically only. No rotational motions are allowed.

Therefore, the system chassis-mounts-engine can be modeled as a 1 degree-of-freedom system: the mass of the engine is m, the mounts have global stiffness k and a suitable viscous damping coefficient c.

i) Determine the inertial forcing due to an L4 2000cc engine. Consider only the first and second-order unbalanced forces caused by reciprocating components motion (Test 1).

ii) Derive the equation of motion of the system, find the natural frequency, the critical damping, and plot the transmissibility $\tau(\omega)$.

iii) Plot the full transient response of the mass and the force transmitted to the chassis when the resonance is crossed (Test 2).