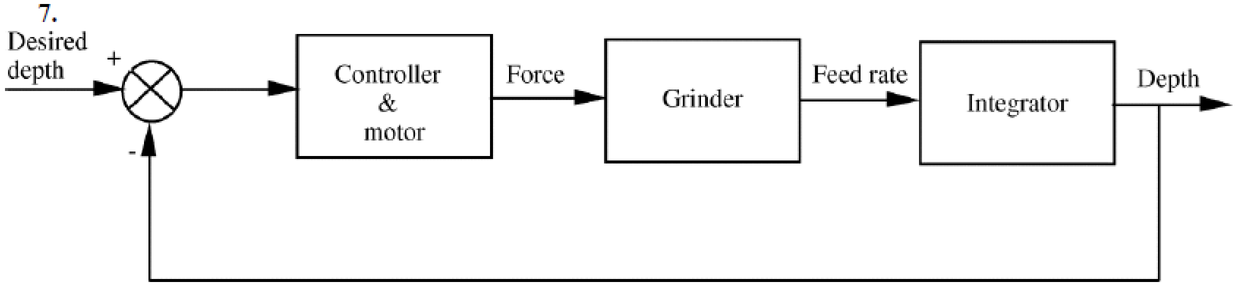
Chapter 1 Solutions

1. Five turns yields 50 v. Therefore K = $\dfrac{50 \text{ volts}}{5 \text{ x } 2\pi \text{ rad}}$ **= 1.59**

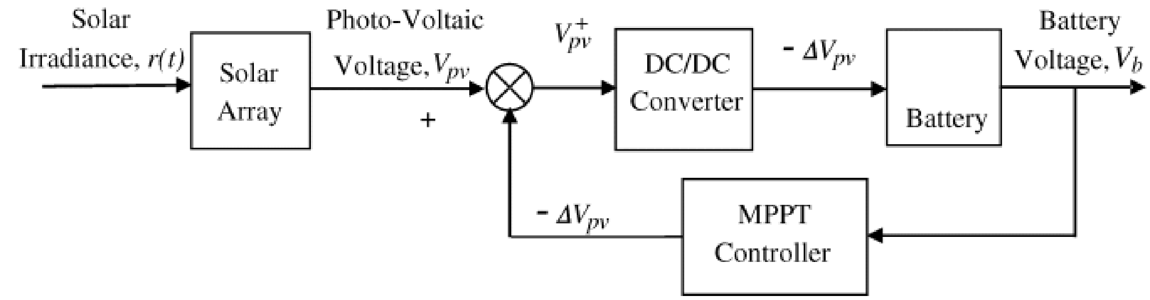
On problem #1, block diagram is just a gain block with a gain of K = 1.59.

7.



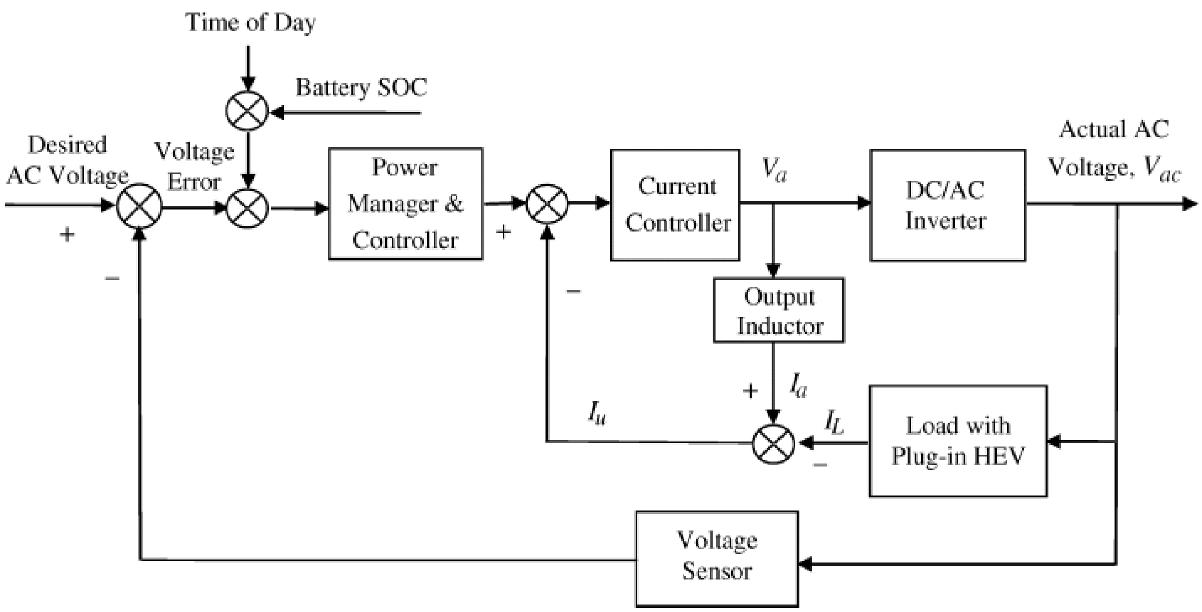
16.

a.



Solar Irradiance, $r(t)$
Solar Array
Photo-Voltaic Voltage, V_{pv}
+
V_{pv}^{+}
DC/DC Converter
$-\Delta V_{pv}$
Battery
Battery Voltage, V_b
$-\Delta V_{pv}$
MPPT Controller

b.



Time of Day
Battery SOC
Desired AC Voltage
+
–
Voltage Error
Power Manager & Controller
+
–
Current Controller
V_a
DC/AC Inverter
Actual AC Voltage, V_{ac}
Output Inductor
+
I_a
I_u
I_L
–
Load with Plug-in HEV
Voltage Sensor

b. Assume a particular solution of

$$x_p = A\sin 3t + B\cos 3t$$

Substitute into the differential equation and obtain

$$(18A - B)\cos(3t) - (A + 18B)\sin(3t) = 5\sin(3t)$$

Therefore, $18A - B = 0$ and $-(A + 18B) = 5$. Solving for A and B we obtain

$$x_p = (-1/65)\sin 3t + (-18/65)\cos 3t$$

The characteristic polynomial is

$$M^2 + 6M + 8 = (M + 4)(M + 2)$$

Thus, the total solution is

$$x = C e^{-4t} + D e^{-2t} + \left(-\frac{18}{65}\cos(3t) - \frac{1}{65}\sin(3t)\right)$$

Solving for the arbitrary constants, $x(0) = C + D - \frac{18}{65} = 0$.

Also, the derivative of the solution is

$$\frac{dx}{dt} = -\frac{3}{65}\cos(3t) + \frac{54}{65}\sin(3t) - 4Ce^{-4t} - 2De^{-2t}$$

Solving for the arbitrary constants, $\dot{x}(0)$ $-\frac{3}{65} - 4C - 2D = 0$, or $C = -\frac{3}{10}$ and $D = \frac{15}{26}$.

The final solution is

$$x = -\frac{18}{65}\cos(3t) - \frac{1}{65}\sin(3t) - \frac{3}{10}e^{-4t} + \frac{15}{26}e^{-2t}$$

#21

b. Assume a particular solution of

$$x_p = Ce^{-2t} + Dt + E$$

Substitute into the differential equation and obtain

$$Ce^{-2t} + Dt + 2D + E = 5e^{-2t} + t$$

Equating like coefficients, C = 5, D = 1, and 2D + E = 0.

From which, C = 5, D = 1, and E = - 2.

The characteristic polynomial is

$$M^2 + 2M + 1 = (M + 1)^2$$

Thus, the total solution is

$$x(t) = Ae^{-t} + Be^{-t}t + 5e^{-2t} + t - 2$$

Solving for the arbitrary constants, x(0) = A + 5 - 2 = 2 Therefore, A = -1. Also, the derivative of the solution is

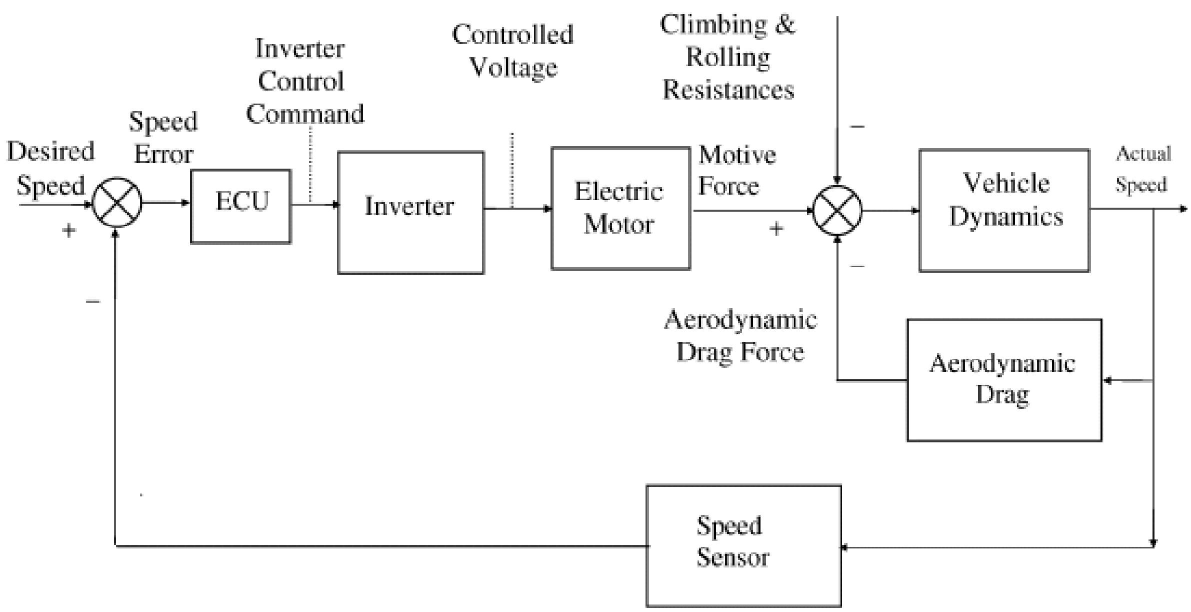
$$\frac{dx}{dt} = (-A + B)e^{-t} - Bte^{-t} - 10e^{-2t} + 1$$

Solving for the arbitrary constants, $\dot{x}(0)$ = B - 8 = 1. Therefore, B = 9. The final solution is

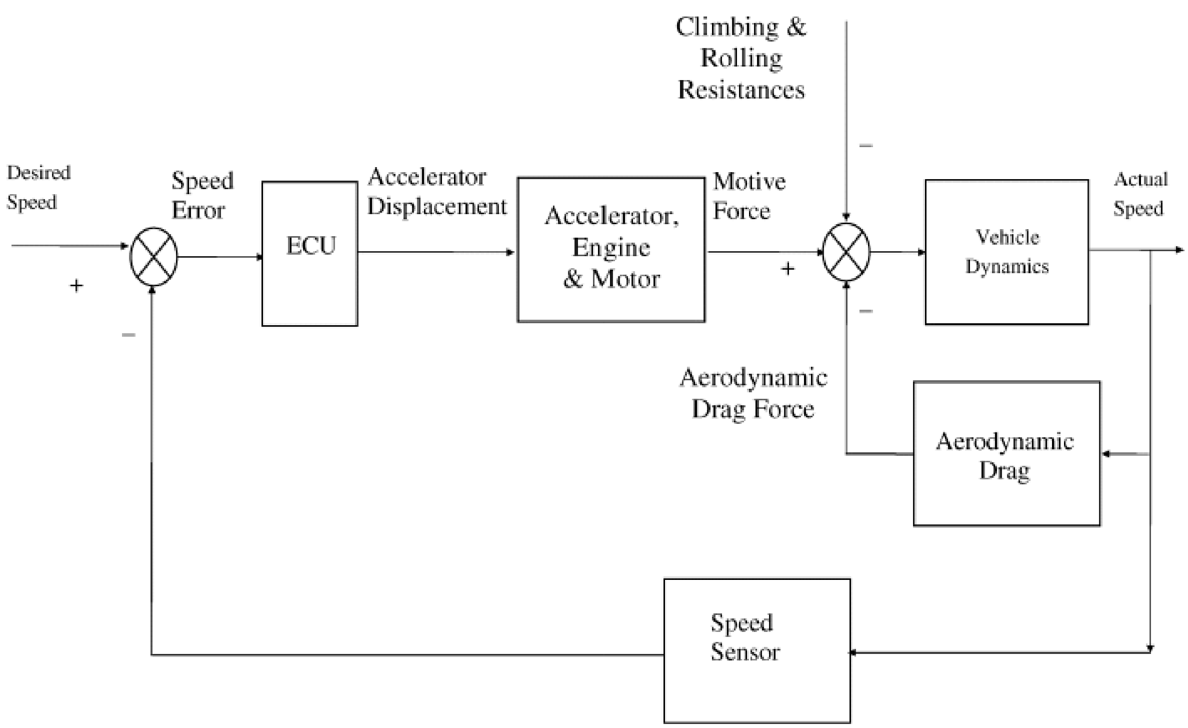
$$x(t) = -e^{-t} + 9te^{-t} + 5e^{-2t} + t - 2$$

23.

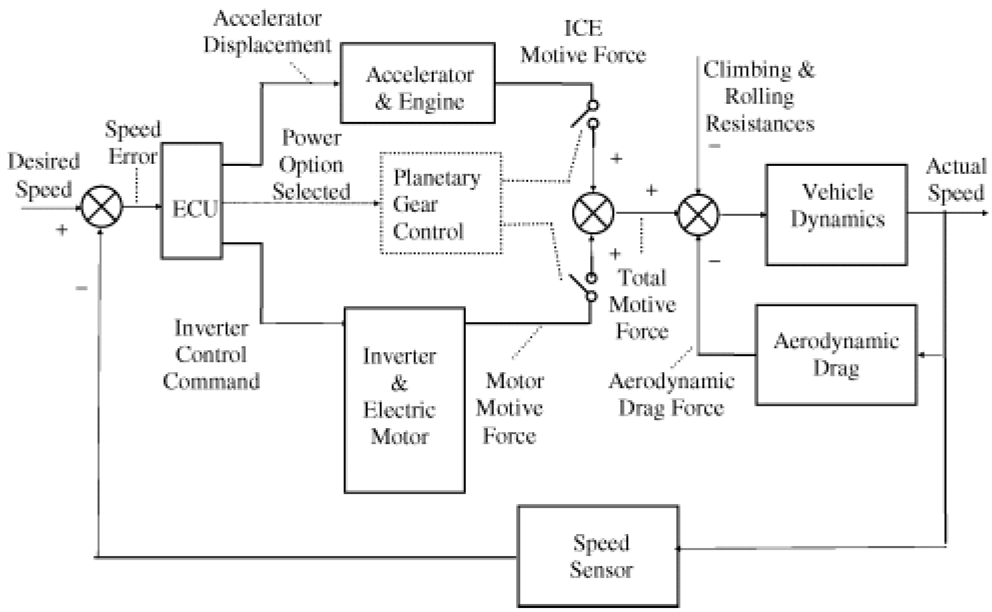
a.


Desired Speed
+
Speed Error
–
ECU
Inverter Control Command
Inverter
Controlled Voltage
Electric Motor
Motive Force
+
Climbing & Rolling Resistances
–
Vehicle Dynamics
Actual Speed
Aerodynamic Drag Force
–
Aerodynamic Drag
Speed Sensor

b.


Desired Speed
+
–
Speed Error
ECU
Accelerator Displacement
Accelerator, Engine & Motor
Motive Force
+
Climbing & Rolling Resistances
–
Vehicle Dynamics
Actual Speed
Aerodynamic Drag Force
–
Aerodynamic Drag
Speed Sensor

c.



Accelerator
Displacement
Accelerator
& Engine
ICE
Motive Force
Climbing &
Rolling
Resistances
Speed
Error
Desired
Speed
ECU
Power
Option
Selected
Planetary
Gear
Control
Vehicle
Dynamics
Actual
Speed
Total
Motive
Force
Inverter
Control
Command
Inverter
&
Electric
Motor
Motor
Motive
Force
Aerodynamic
Drag
Aerodynamic
Drag Force
Speed
Sensor