Note that negative marking is to be applied and as such avoid guessing solutions.

1) The paper titled ”On Governors”’ is deemed by many to mark to birth of control theory. Who was the author?
   a) Rudolf E Kalman
   b) Claude Shannon
   c) James Clerk Maxwell
   d) Aleksandr Lyapunov
   e) Albert Einstein [2 marks]

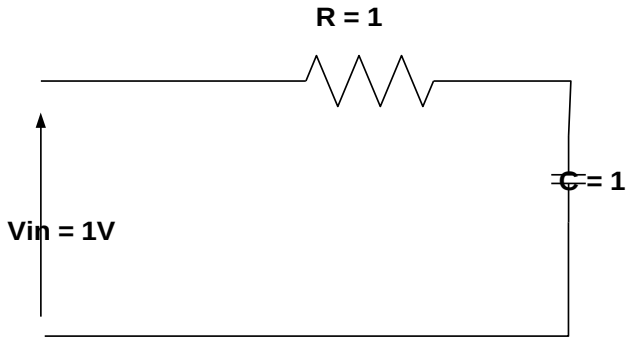

Fig. 1: question 2

2) Consider the RC circuit shown in figure 1. The output is the capacitor voltage with the capacitor initially discharged. At what time will the capacitor voltage have risen to 0.632 Volts
   a) 1 second
   b) 1 minute
   c) 5 seconds
   d) 10 seconds
   e) 100 seconds [1 mark]

3) A thermometer requires 1 minute to indicate 98% of the response to a step input. Assuming the thermometer to be a first order system. What is the time constant of the thermometer to the nearest second.
   a) 15 seconds
   b) 37 seconds
   c) 45 seconds
   d) None of the above
   e) All of the above [3 marks]

The following information is applicable to Questions 4 and 5

The following statements describe the response of a first order system to a step input.

i. the system output will reach its steady state value without overshoot
ii. the system output can grow exponentially to infinity
iii. the system output will oscillate before reaching its steady state value
iv. the system output approaches steady state in a shorter time as the time constant increases

4) Which of the above statements describe possible responses of a first order system to a step input
   a) Only (i) is correct
   b) (iv) and (i)
   c) (ii) and (iii) are correct
   d) None of the above, (a) (b) or (c), are correct.
   e) All of the above statements, (i) (ii) (iii) and (iv), are correct. [3 marks]

5) Which of the above statements describe possible responses of a first order system to a step input
   a) Both (i) and (ii) are correct
   b) Only (iii) is correct
   c) Only (iv) is correct
   d) None of the above, (a) (b) or (c), are correct
   e) All of the above statements, (i) (ii) (iii) and (iv), are incorrect. [3 marks]

6) Consider a first order system described by the transfer function

$G(s) = 1/(s + 1/T)$

If the system is excited by a ramp function of slope *k*. The steady state error of the system is

a) 0.5
b) T
c) 2T
d) *k*
e) none of the above [3 marks]

The following information is applicable to Questions 7 and 8

s_1 and s_2 are the poles of a second order system which of the following statements about the poles is true

i. s_1 is real and s_2 is complex
ii. both s_1 and s_2 are real
iii. s_1 is real and less than -1 while s_2 is real negative but greater than -1
iv. both s_1 and s_2 are complex

7) Which of the following statements about the poles is true

a) Only (iv) is correct
b) (i) (ii) and (iii) are correct
c) Only (ii) and (iv) are correct
d) None of (a) (b) or (c) above are correct
e) None of (i) (ii) (iii)and (iv) are correct [3 marks]

8) Which of the following statements about the poles is true

a) Only (ii) is correct
b) (ii) (iii) and (iii) are correct
c) Only (ii) and (iii) are correct
d) None of (a) (b) or (c) above are correct
e) All of (i) (ii) (iii)and (iv) are correct [3 marks]

9) Consider the second order system given by

$$\ddot{y} - 4\dot{y} + 9y = 0$$

Which of the following expressions show the correct general solution to the equation

a) $c_1 e^{-1t} + c_2 e^{3t}$
b) $c_1 e^{2t} cos(\sqrt{5}t) + c_2 e^{2t} sin(\sqrt{5}t)$
c) $A e^{2t} sin(\sqrt{5}t) + \varphi$
d) None of the above

where c_1, c_2, A, φ are constants [4 marks]

10) $y(t) = 5e^{-2t} + 2e^{-t}$ is the general solution of a second order differential equation with initial conditions $y(0) = 0$ and $\dot{y}(0) = 1$. Which differential equation has this general solution?

a) $\ddot{y} + 3\dot{y} + 2y = 0$
b) $\ddot{y} - 8\dot{y} + 17y = 0$
c) $4\ddot{y} + 24\dot{y} + 8y = 0$
d) none of the above [4 marks]

11) A unity gain second order system is subject to a unit step input, its transient response contains a first overshoot of 77%, occuring after 32.5ms. What is the damped frequency of the system?

a) 100rad/s
b) 96.66rad/s
c) 96.99rad/s
d) 99.69rad/s
e) None of the above [3 marks]

12) For the system in question 11 what is the undamped frequency of the system?

a) 100rad/s
b) 96.66rad/s
c) 96.99rad/s
d) 99.69rad/s
e) None of the above [3 marks]

13) Figure Q13 shows the typical impulse response of a system with time constant τ= 0.2s

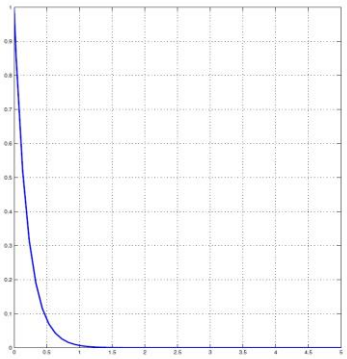

Figure Q13

What would the unit step response be

a) $5e^{-t}$
b) e^{-5t}
c) $5(1-e^{-t})$
d) $1-e^{-5t}$
e) $1-e^{-0.2t}$

14) The complete output function in the *s-domain* of the block diagram in Figure Q14 is

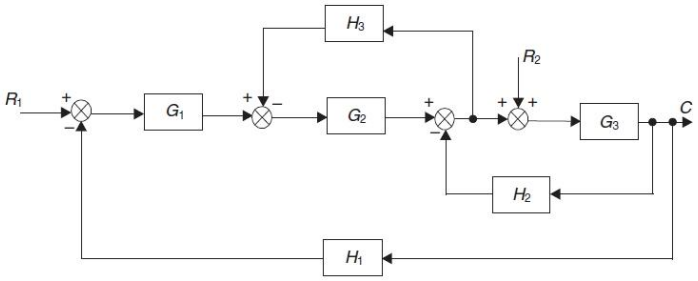

Figure Q14 Burns

a) $C(s) = ((G\_1\ (s)\ G\_2\ (s)\ G\_3\ (s))\ R\_1\ (s))/(1+\ G\_3\ (s)\ H\_2\ (s) + G\_2\ (s)\ H\_3\ (s) + G\_1\ (s)\ G\_2\ (s)\ G\_3\ (s)\ H\_1\ (s)\ )$
b) $C(s) = ((G\_1\ (s)\ G\_2\ (s)\ G\_3\ (s))\ R\_1\ (s) + G\_3\ (s)(1 + G\_2\ (s)\ H\_3\ (s))\ R\_2\ (s))/(1+\ G\_3\ (s)\ H\_2\ (s) + G\_2\ (s)\ H\_3\ (s) + G\_1\ (s)\ G\_2\ (s)\ G\_3\ (s)\ H\_1\ (s)\ )$
c) $C(s) = ((G_1(s)G_2(s)G_3(s))R_1(s) - G\_3\ (s)(1 + G\_2\ (s)\ H\_3\ (s))\ R\_2\ (s))/(1+\ G\_3\ (s)\ H\_2\ (s) + G\_2\ (s)\ H\_3\ (s) + G\_1\ (s)\ G\_2\ (s)\ G\_3\ (s)\ H\_1\ (s)\ )$
d) $C(s) =$
$((G_1(s)G_2(s)G_3(s))R_1(s) - G\_3\ (s)(1 + G\_2\ (s)\ H\_3\ (s))\ R\_2\ (s))/(1-\ G_3(s)H_2(s) - G_2(s)H_3(s) - G\_1\ (s)\ G\_2\ (s)\ G\_3\ (s)\ H\_1\ (s)\ )$