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1. using conditional probability density function



according to the bivariate normal distribution density formula



Where 



Since 

So the density of it is 

Then 

2. let



The right term is easy to get since Wt is a martingale , so it equals to 3tWs



Then add them up

sum equal to:

So , it is a martingale

3.

.

4.To know the distribution , we should know the mean and var



Since  ,so the right hand side of the equation is a summation of Normal distributions whose means are all zero ,then times 1/n ;but that doesn’t change the mean. So the expectation should be zero too.



For s<t:



So  

5. According to problem 3



So the expectation of it is



Next is to figure out the variance

According to Ito Isometry



So its distribution is 

6.

Expectation:



According to Ito’s formula



Where



So:



Equation=

Since mean=0;

Var:



Its distribution is 

7.

According to ito’s formula :

Let 



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Since g is a “nice” deterministic function, so