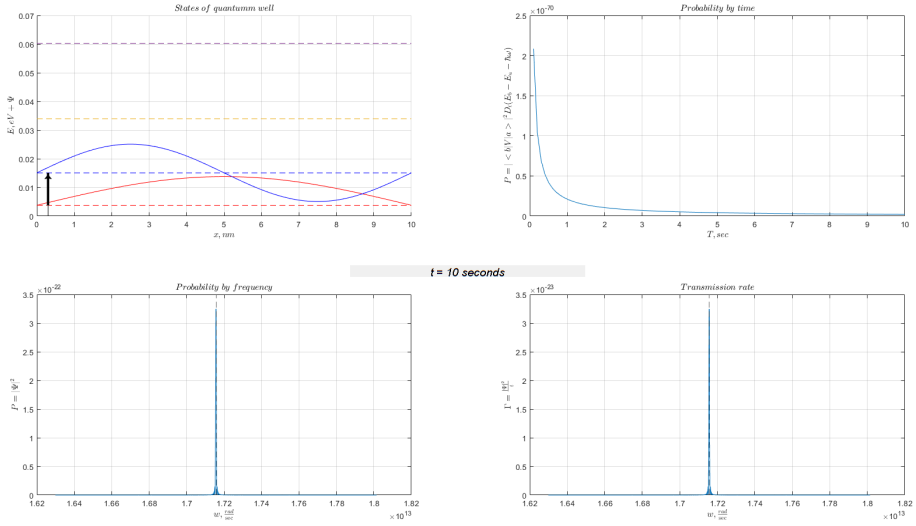
```
close all
clear
clc

T=500;%time in seconds

fig=figure('Name','Method of variations','NumberTitle','off');
fig.Units='normalized';
fig.Position=[1 0 1 1];

hbar=1.0546e-34;
m0=9.1e-31;
e=1.6e-19;

%forming a task
L=1e-8;
Np=1000;
x=linspace(0,L, Np)';

%setting Time-value
T=10^(1);

%defining potential feild and perturbation
%U=zeros(Np);                        %inf quantum well
Upetr=diag(ones(1,Np));              %time dependet perturbation
p=@(n)sqrt(2/L).*sin(pi*n*x/L);      %n-th state
E=@(n)pi^2*hbar^2/(2*m0*L^2)*(n^2); %n-th energy

%defining states
a=1;  b=2;
p1=p(a); p1=p1/sqrt(p1'*p1); E1=E(a);
p2=p(b); p2=p2/sqrt(p2'*p2); E2=E(b);
w=(E2-E1)/hbar;                              %allowed frequency for a->b
W=linspace(w*0.95, 1.05*w, Np);              %araay of frequncies

%defining golden fermi rule function
D=@(E,t)4*sin(E.*t/(hbar*2)).^2./E.^2;
d=@(E,t)hbar./(2*pi*t).*D(E,t);
P=@(w,t)abs(p2'*Upetr*p1)^2.*(d(E2-E1-w*hbar,t));
P1=@(w,t)abs(p2'*Upetr*p1)^2*hbar./(2*pi*t);
% P=@(w,t)abs(p2'*Upetr*p1)^2.*2*pi*t/hbar;
G=@(t)P(W,t)/t;

%visualization
%a and b states, considered transmition from a to b
subplot(2,2,1)
hold off
grid on
hold on
for i=1:(max(a,b)+2)
    plot([0 L]*1e9, E(i)*[1 1]/e,'--')
end
```

```
plot([0 L]*1e9, [1 1]*E1/e,'--r')
plot([0 L]*1e9, [1 1]*E2/e,'--b')
plot(x*1e9, E1/e+p1/max(p1)/100,'r')
plot(x*1e9, E2/e+p2/max(p2)/100,'b')
plot([0.3 0.3], [E1 E2]/e,'b','Color', [0 0 0],'LineWidth', 3)
h=annotation('arrow');
set(h,'parent', gca,'position', [0.3 E1/e 0 (E2-E1)/e],'HeadLength',
 10,...
    'HeadWidth', 10, 'HeadStyle', 'hypocycloid','Color', [0 0
 0], 'LineWidth', 0.5);
xlabel('$x,nm$', 'Interpreter', 'latex');
ylabel('$E,eV + \Psi$', 'Interpreter', 'latex');
title('$States$ $of$ $quantumm$ $well$', 'Interpreter', 'latex');

%dependence of transition by time
t=linspace(0,T);
subplot(2,2,2)
hold off
plot(t,P1(w,t))
hold on
grid on
xlabel('$T,sec$', 'Interpreter', 'latex');
ylabel('$P=|<b|V|a>|^2D_t(E_b-E_a-\hbar
\omega)$', 'Interpreter', 'latex');
title('$Probability$ $by$ $time$', 'Interpreter', 'latex');

%dependence of probability by frequency
subplot(2,2,3)
hold off
plot(W,P(W,T))
hold on
grid on
xline(w,'--')
xlabel('$w,{rad\over \sec}$', 'Interpreter', 'latex');
ylabel('$P=|\Psi|^2$', 'Interpreter', 'latex');
title('$Probability$ $by$ $frequency$', 'Interpreter', 'latex');

%dependence of rate of transition by frequency
subplot(2,2,4)
hold off
plot(W,G(T))
hold on
grid on
xline(w,'--')
xlabel('$w,{rad\over \sec}$', 'Interpreter', 'latex');
ylabel('$\Gamma={|\Psi|^2\over t}$', 'Interpreter', 'latex');
title('$Transmission$ $rate$', 'Interpreter', 'latex');

%interfacing time-value
Timeis=uicontrol('style','text','String',['t = ', num2str(T),'
 seconds'],...

  'FontSize',14,'FontAngle','italic','HorizontalAlignment','center');
Timeis.Units='normalized';
```

```
Timeis.Position=[0.41 0.48 0.21 0.02];
```



Published with MATLAB® R2020b