Assignment 0

The due date for submitting this assignment has passed.
Due on 2018-07-30, 23:59 IST.
As per our records you have not submitted this assignment.

Note to Students: The quiz given below tests your mathematical preparation for this MOOCs course. If you are not entirely ready and are not able to solve all the problems, please do not worry. I suggest that you study the math lesson that is given as lesson zero or, as a prerequisite lesson. Also revise the math that you have learnt in your high school (CBSE, Class XI and Class XII). Many of the problems given here will appear again in the text/videos and also as applications in elementary model problems of quantum mechanics.

1) The second derivative \( \frac{d^2}{dx^2} \) of the function \( e^{ax} \) is
   - \( e^{ax} \)
   - \( ae^{ax} \)
   - \( a^2 e^{ax} \)
   - \( x^2 e^{ax} \)
   - \( \frac{d}{dx} \)

No, the answer is incorrect.
Score: 0
Accepted Answers:

2) The second derivative \( \frac{d^2}{dx^2} \) of the function \( e^{-ax^2} \) is
   - \( a^2 e^{-ax^2} \)
   - \( -2xe^{-ax^2} \)
   - \( a^2 x^2 e^{-ax^2} \)
   - \( (4ax^2 - 2a)e^{-ax^2} \)
   - \( \frac{d}{dx} \)

No, the answer is incorrect.
Score: 0
Accepted Answers:
4) The function \( f(x) = Ae^{kx} + Be^{-kx} \) satisfies the differential equation (\( A \) and \( B \) are constants),

\[
\frac{df}{dx} + kf(x) = 0 \\
\frac{df}{dx} - kf(x) = 0 \\
\frac{d^2f}{dx^2} + k^2f(x) = 0 \\
\frac{d^2f}{dx^2} - k^2f(x) = 0
\]

No, the answer is incorrect.
Score: 0
Accepted Answers:
\( \frac{d^2f}{dx^2} - k^2f(x) = 0 \)

5) For the function \( f(x) = e^{kx} \), let \( f(x) \) double each time \( x \) is increased by \( x_0 \).

That is,

\[
f(x) = u \\
f(x + x_0) = 2u \\
f(x + 2x_0) = 4u \\
\vdots
\]

The value of \( k \) is

\[
\frac{\ln{2}}{x_0} \\
\frac{\ln{x_0}}{2} \\
\ln\left(\frac{2}{x_0}\right) \\
\ln{2x_0}
\]

No, the answer is incorrect.
Score: 0
Accepted Answers:
6) For the function $xe^{-kx}$, with $k > 0$, the maximum is given by

- $x = k$
- $x = 2 + \frac{1}{k}$
- $x = 1$
- $x = \frac{1}{k}$
- $x = 2$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$x = \frac{1}{k}$

7) The integral $\int_{0}^{\infty} e^{-kx} dx$ with $k > 0$ has a value $\frac{1}{k}$. For $n$, an integer in the range $0 < n < \infty$, the value of the integral $\int_{0}^{\infty} x^n e^{-kx} dx$ is

- $\frac{n!}{k^n}$
- $n!$
- $\frac{n!}{k^{n+1}}$
- $\frac{k}{n!}$
- $\frac{n!}{k^{n+1}}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{n!}{k^{n+1}}$

8) The integral $\int_{0}^{\infty} e^{-kx} \cos bx \, dx$, $k > 0$, $b$ a constant, has the value

- $\frac{k}{k^2 + b^2}$
- $\frac{b}{k^2 + b^2}$
- $\frac{kb}{k^2 + b^2}$
- $\frac{kb}{k^2 + b^2}$

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The integral \( \int_0^\infty x^n e^{-x^2} \, dx \) with \( n > 1 \) is associated with Gamma function and is represented as \( \Gamma(n) \). Identify the correct statement below:

- \( \Gamma(n+1) = (n+1)\Gamma(n) \)
- \( \Gamma(n+1) = n\Gamma(n) \)
- \( \Gamma(n+1) = n\Gamma(n-1) \)
- \( \Gamma(n+1) = (n-1)\Gamma(n-1) \)

The minimum of the function \( xe^{-ax^2} \) is given by:

- \( x = \frac{1}{2a} \)
- \( x = \frac{1}{\sqrt{2a}} \)
- \( x = \frac{-1}{2a} \)
- \( x = \frac{-1}{\sqrt{2a}} \)

The integral \( \int_{-\infty}^{\infty} xe^{-x^2} \, dx \) has a value of

- zero
- 1
- 1/2
- 2

No, the answer is incorrect.
Score: 0
Accepted Answers: zero
12) The integral \( \int_0^\infty x^2 e^{-x^2} \, dx \) has a value of

- zero
- \( \frac{1}{a} \sqrt{\frac{\pi}{a}} \)
- \( \frac{1}{2a} \sqrt{\frac{\pi}{a}} \)
- \( \frac{1}{4a} \sqrt{\frac{\pi}{a}} \)

No, the answer is incorrect.
Score: 0
Accepted Answers:

\( \frac{1}{4a} \sqrt{\frac{\pi}{a}} \)

13) The integral \( \int_0^\infty e^{-x^2} \, dx \) has a value of \( \sqrt{\frac{\pi}{a}} \) and the integral \( \int_{-\infty}^\infty x^2 e^{-x^2} \, dx \) has the value \( \frac{1}{2a} \sqrt{\frac{\pi}{a}} \). The value for the integral \( \int_{-\infty}^\infty x^{2n} e^{-x^2} \, dx \) with \( a \) and \( n \) being positive integers, is given by

- \( \frac{(2n)!}{(2a)^n} \sqrt{\frac{\pi}{a}} \)
- \( (2n-1)(2n-3)(2n-5)\ldots3.1 \sqrt{\frac{\pi}{a}} \)
- \( \left( \frac{\pi}{a} \right)^n \)
- None of the above.

No, the answer is incorrect.
Score: 0
Accepted Answers:

\( (2n-1)(2n-3)(2n-5)\ldots3.1 \sqrt{\frac{\pi}{a}} \)

14) The function \( f(x) = Ae^{ikx} + Be^{-ikx} \) satisfies the differential equation, \( A, B \) are real constants

- \( \frac{df}{dx} + ikf(x) = 0 \)
- \( \frac{df}{dx} - ikf(x) = 0 \)
A qubit is a superposition of two distinguishable spin-1/2 states and is represented by the states $|a\rangle + b|\beta\rangle$ where the constants are the information carriers. (Constants for this problem). The individual states $|a\rangle$ and $|\beta\rangle$ are eigenfunctions of the polarization (or Spin) operator $P_z$. The expectation value for the $x$ component of polarization (spin) is

$$\frac{d^2 f}{dx^2} + k^2 f(x) = 0$$

$1)$ No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\frac{d^2 f}{dx^2} + k^2 f(x) = 0$$

15) A qubit is a superposition of two distinguishable spin-1/2 states and is represented by the states $a|a\rangle + b|\beta\rangle$ where the constants are the information carriers. (Constants for this problem). The individual states $|a\rangle$ and $|\beta\rangle$ are eigenfunctions of the polarization (or Spin) operator $P_z$. The expectation value for the $x$ component of polarization (spin) is

$$\frac{1}{2} (a^*a + b^*b) \left( |a|^2 + |b|^2 \right)$$

$$\frac{1}{2} (a^*b + b^*a) \left( |a|^2 + |b|^2 \right)$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\frac{1}{2} (a^*b + b^*a) \left( |a|^2 + |b|^2 \right)$$