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MATH1014 Final Exam: May 23, 18:30-20:30

Started: May 23 at 6:30pm

Quiz Instructions

Examination Time: 18:30-20:30

- You can submit answers at most once. Do not submit answers until you really want to end the exam.
- Canvas saves the answer entered to each question as you go. So if you get disconnected, just log right back. If you do not click the "Submit Quiz" button at the bottom of the quiz page, Canvas will submit answers automatically at due time.
- No multiple attempts.
- According to the exam regulations of the HKUST, student may NOT leave during the first 30 minutes and the last 30 minutes of the exam. If you want to leave before the end of the exam, first submit your answers, and then send a request for leaving via the Chat Room of Zoom. You may leave after you get the approval of the instructor.
- This is an open book, notes exam, but **electronic books or notes are not allowed**.
- Calculator of any kind, computation software, unauthorized websites, etc., are NOT allowed.**
- Your must join the proctoring Zoom meeting for this exam. Your exam will be void if you do not do so.
- In case you are disconnected from Canvas or the Zoom meeting, reconnect as soon as possible.
- This exam is recorded by Zoom in the Cloud. If you do not show your face and exam setting according to the regulations via the webcam throughout the exam, your exam will be void.
- Follow instructions if you are contacted by an invigilator during the exam, otherwise you exam will be void.**
- By taking this exam, you agree to follow the Academic Code of HKUST, and not to receive any unauthorized aid during the exam.

Questions

- Question 1
- Question 14
- Question 15
- Question 16
- Question 17
- Question 18
- Question 19
- Question 20
- Question 21

Time Running: [Hide](#)
Attempt due: May 23 at 8:30pm
1 Hour, 38 Minutes, 14 Seconds

Question 1

0 pts

Sanctions will be imposed on students, if they are found to have violated the regulations governing academic integrity and honesty.

You must confirm the following for taking this exam, otherwise your exam will be void.

- I will answer the questions using only materials allowed for use in this examination
- I will not receive any assistance during the examination and that all the answers will be by own work
- I will not consult any online materials unless with the explicit written consent of my instructor
- I am taking this examination in isolation, i.e., not communicating with any other channel for unauthorized aid
- I am using my own ITSC account to complete this examination.

☒ I confirm the five statements above

Question 2

5 pts

Find the average value of the function $y = \sin x$ over the interval $[0, \pi]$.

☐ 1

☐ $\frac{1}{2}$

☐ $\frac{1}{2\pi}$

☒ $\frac{2}{\pi}$

☐ $\frac{1}{\pi}$

Question 3

5 pts

$r^{\frac{\pi}{\pi}}$

Evaluate the integral $\int_0^4 5 \cos(3x) \cos(2x) dx$.

- ☐ 6
- ☐ 4
- ☐ 5
- ☐ 2
- ☒ 3



Question 4

5 pts

Evaluate the integral $\int_0^{\frac{\pi}{12}} 30 \tan^4(3x) \sec^2(3x) dx$.

- ☐ 5
- ☐ 3
- ☐ 1
- ☒ 2
- ☐ 4



Question 5

5 pts

The area between the graph of $y = x^2 e^{-2x^4}$ and the x-axis over the infinite interval $[0, \infty]$ is rotated about the y-axis to generate a solid of revolution. Find the volume of the solid.

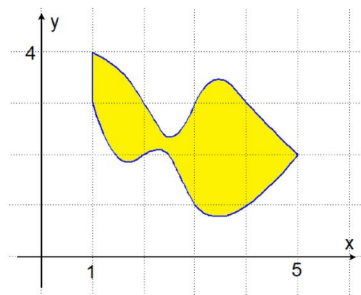
- ☒ $\frac{\pi}{4}$
- ☐ 2π
- ☐ $\frac{3\pi}{4}$
- ☐ $\frac{5\pi}{4}$
- ☐ $\frac{\pi}{2}$



Question 6

5 pts

The region between the two graphs given in the following figure is rotated about the x-axis to generate a solid of revolution. If Simpson's rule with four subintervals of equal length is used to estimate the volume of the solid, what is the approximate volume of the solid thus obtained?



- ☒ 25π
- ☐ 32π
- ☐ 36π
- ☐ 13π
- ☐ 18π

**Question 7**

5 pts

Evaluate the integral $\int_0^1 (x-2)f''(x) dx$, given that

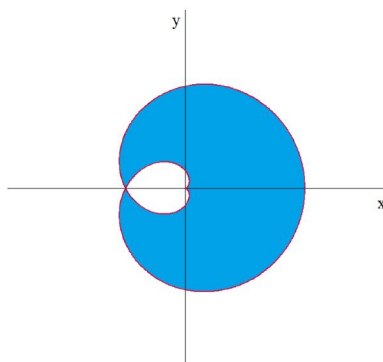
$x =$	0	1	2
$f(x) =$	1	2	-1
$f'(x) =$	2	0	1

☐ 2☒ 3☐ 5☐ 6☐ 4**Question 8**

5 pts

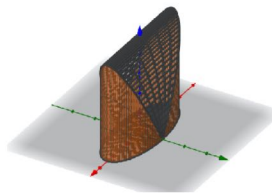
Find the shaded area between the two loops of the curve defined by the polar equation

$$r = \frac{1}{2}(1 + \cos \frac{\theta}{2}).$$

☒ 2☐ 10☐ 6☐ 4☐ 8**Question 9**

5 pts

The base of a solid sitting on the xy -plane is the region enclosed by the ellipse given by the equation $\frac{x^2}{6} + y^2 = 1$. Suppose that the cross sections of the solid perpendicular to the y -axis are squares. Find the volume of the solid.

☐ 8☒ 32☐ 16☐ 24☐ 28



Question 10

5 pts

Evaluate the integral $\int_3^{\infty} \frac{6}{x^2 \sqrt{x^2 - 9}} dx$.

☐ $\frac{3}{2}$

☐ $\frac{1}{3}$

☐ $\frac{4}{3}$

☒ $\frac{2}{3}$

☐ $\frac{1}{2}$



Question 11

5 pts

Evaluate the integral $\int_{-\infty}^{\infty} \frac{6e^x}{(e^x + 3)(e^x + 6)} dx$.

☒ $2 \ln 2$

☐ $\ln 2$

☐ $4 \ln 2$

☐ $5 \ln 2$

☐ $3 \ln 2$



Question 12

5 pts

Which of the following integrals is convergent?

☐ (i) $\int_1^{\infty} \frac{2x}{1+x^2} dx$

☒ (ii) $\int_1^{\infty} \frac{\ln x}{2+e^x} dx$

☐ (iii) $\int_1^{\infty} \frac{3^x}{3^x+4} dx$

☐ (iv) $\int_1^{\infty} \frac{1}{1+\ln x} dx$

☐ (v) $\int_1^{\infty} \frac{e^{\sin x}}{x+2\sqrt{x}} dx$

☐ (v)

☒ (ii)

☐ (i)

☐ (iv)

☐ (iii)



Question 13

5 pts

Find the length of the graph of the function defined by $y = \ln \sec x$, where $0 \leq x \leq \frac{\pi}{3}$.

☐ $\ln 3$

☐ $\frac{1}{2} \ln(\sqrt{3} + 2)$

☐ $\frac{1}{2} \ln 3$

☒ $\ln(\sqrt{3} + 2)$

☒ $\ln(\sqrt{3} + 1)$



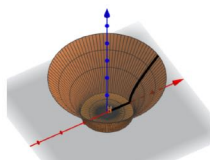
Question 14

5 pts

The shape of a tank is the same as the surface of revolution obtained by rotating the graph of the function defined by

$$y = \begin{cases} 0, & \text{if } 0 \leq x < 1 \\ \sqrt{x^2 - 1}, & \text{if } 1 \leq x \leq \sqrt{5} \end{cases}$$

about the y-axis. If the tank is full of water, which of the following integral represents the work required to pump all water to an outlet 4 meters above the bottom of the tank? (x, y in meters; water density: ρ kg/m³; gravity acceleration: g m/s².)



☒ $\pi \rho g \int_0^2 (4 - y + 4y^2 - y^3) dy$

☐ $\pi \rho g \int_0^2 (4 - y - 3y^2 - y^3) dy$

☐ $\pi \rho g \int_0^4 (4 - y - 3y^2 - y^3) dy$

☐ $\pi \rho g \int_0^2 (4 - 3y + y^2 - y^3) dy$

☐ $\pi \rho g \int_0^4 (4 - y + 2y^2 - y^3) dy$



Question 15

5 pts

The sequence recursive defined by

$$a_{n+1} = \frac{3}{a_n + 2}, \quad a_1 = 2$$

has a limit L . Find L .

☒ $L = 1$

☐ $L = 2$

☐ $L = -3$

☐ $L = 3$

☐ $L = \frac{3}{2}$



Question 16

5 pts

Find all convergent infinite sequences from the following:

(i) $\frac{2 + \sqrt{n}}{\sqrt{n} + \ln n}$

(ii) $\frac{(-1)^n n^2}{e^n}$

(iii) $\frac{n!}{n^n}$

(iv) $\frac{\sin(\pi^n)}{\sqrt{n}}$

☒ All are convergent

☐ Only (ii) and (iv) are convergent

☐ Only (i) and (ii) are convergent

☐ Only (i), (iii) and (iv) are convergent

☐ Only (i), (ii) and (iv) are convergent

Question 17 5 pts

Find the sum of the infinite series $\sum_{n=1}^{\infty} \frac{4^{n+1} - 2 \cdot 3^{n-1}}{5^{n+1}}$.

☐ 5
☐ 7
☐ 4
☐ 6
☒ 3

Question 18 5 pts

Find the sum of the infinite series $\sum_{k=1}^{\infty} 4^{\frac{1}{k+1}} \left(4^{\frac{1}{k(k+1)}} - 1 \right)$.

☐ 8
☐ 3
☐ 2
☐ 4
☒ divergent

Question 19 5 pts

Find all convergent infinite series from the following:

(i) $\sum_{n=1}^{\infty} (-1)^{n+1} n \sin \frac{1}{n}$ (ii) $\sum_{n=1}^{\infty} \frac{1}{n\sqrt{n+1}}$ (iii) $\sum_{n=1}^{\infty} \frac{\ln n}{n^2 + 1}$ (iv) $\sum_{n=1}^{\infty} \frac{(2n!)}{n^{2n}}$ (v) $\sum_{n=1}^{\infty} \frac{\tan^{-1} n}{n}$

☐ Only (i), (iii) and (iv) are convergent
☒ Only (ii), (iii) and (iv) are convergent
☐ Only (ii) and (iii) are convergent
☐ Only (iii) and (iv) are convergent
☐ Only (ii), (iii) and (v) are convergent

Question 20 5 pts

Find the radius of convergence of the power series $\sum_{n=0}^{\infty} \frac{2n^2 + 1}{3^n} (x - 1)^n$.

☒ 3
☐ $\frac{1}{3}$
☐ $\frac{3}{2}$
☐ $\frac{2}{3}$
☐ ∞

Question 21 5 pts

Find $f^{(6)}(0)$ where $f(x) = \frac{\cos(x^2)}{x}$ where $f^{(6)}(x)$ stands for the sixth order derivative of

$\frac{f^{(5)}(x)}{5!} = 1 - x^2$

$f(x)$.

☐ 4

☐ 5

☒ 3

☐ 6

☐ 2