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15.20 — HIGHER ENGINEERING MATHEMATICS-IV

Substituting (2), (3), (4) in (1), we get

$$\nabla^2 \ln r = \frac{r^2 - 2z^2}{r^4} + \frac{r^2 - 2y^2}{r^4} + \frac{r^2 - 2x^2}{r^4} \\ = \frac{3r^2 - 2(x^2 + y^2 + z^2)}{r^4} = \frac{3r^2 + 2r^2}{r^4} = \frac{r^2}{r^4} = \frac{1}{r^2}.$$

Example 4: Prove that

$$\nabla^2(fg) = f\nabla^2g + 2\nabla f \cdot \nabla g + g\nabla^2f.$$

Solution:

$$\begin{aligned} \nabla^2(fg) &= \nabla \cdot \nabla(fg) \\ &= \nabla \cdot [f\nabla g + g\nabla f] \\ &= \nabla \cdot (f\nabla g) + \nabla \cdot (g\nabla f) \\ &= [f\nabla \cdot \nabla g + \nabla f \cdot \nabla g] + [g\nabla \cdot \nabla f + \nabla g \cdot \nabla f] \\ &= f\nabla^2g + 2\nabla f \cdot \nabla g + g\nabla^2f. \end{aligned}$$

Example 5: Find the directional derivative of $\nabla \cdot (\nabla f)$ at the point $(1, -2, 1)$ in the direction of the normal to the surface $xy^2z = 3x + z^2$ where $f = 2x^3y^2z^4$.

Solution: Let

$$\begin{aligned} U(x, y, z) &= \nabla \cdot \nabla f = \nabla^2 f = \nabla^2(2x^3y^2z^4) \\ &= \left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} \right) (2x^3y^2z^4) \\ &= 2 \cdot [6xy^2z^4 + 2x^3z^4 + 12x^3y^2z^2] \end{aligned}$$

Normal to the surface $g = xy^2z - 3x - z^2 = 0$ is

$$\begin{aligned} \nabla g &= (y^2z - 3)\vec{i} + (2xyz)\vec{j} + (xy^2 - 2z)\vec{k} \\ \nabla g \Big|_{(1, -2, 1)} &= \vec{i} - 4\vec{j} + 2\vec{k} \end{aligned}$$

Unit vector \hat{a} in the direction of normal at the point $P(1, -2, 1)$ is

$$\hat{a} = \frac{\nabla g}{|\nabla g|} = \frac{\vec{i} - 4\vec{j} + 2\vec{k}}{\sqrt{1 + 16 + 4}} = \frac{\vec{i} - 4\vec{j} + 2\vec{k}}{\sqrt{21}}$$

Consider

$$\begin{aligned} \nabla^2 U &= \nabla \cdot (\nabla^2 f) = \nabla \cdot (12x^3y^2z^4 + 48x^3z^4 + 24x^3y^2z^2) \\ &= (12x^2z^4 + 12x^2z^2 + 72x^2y^2z^2)\vec{i} \\ &\quad + (24xyz^4 + 48x^3yz^2)\vec{j} \\ &\quad + (48x^3y^2z^2 + 16x^3z^3 + 48x^3y^2z^2)\vec{k} \\ \nabla^2 U \Big|_{(1, -2, 1)} &= 348\vec{i} - 144\vec{j} + 400\vec{k} \end{aligned}$$

Thus the required directional derivative is

$$\nabla U \cdot \hat{a} = (348\vec{i} - 144\vec{j} + 400\vec{k}) \cdot \frac{(\vec{i} - 4\vec{j} + 2\vec{k})}{\sqrt{21}} = \frac{348 - 576 + 800}{\sqrt{21}} = \frac{672}{\sqrt{21}}.$$

Example 6: Evaluate $\nabla^2 \left[\nabla \cdot \left(\frac{\vec{r}}{r^2} \right) \right]$

Solution: Consider

$$\begin{aligned} \nabla \cdot \left(\frac{\vec{r}}{r^2} \right) &= \nabla \cdot (r^{-2}\vec{r}) \\ &= r^{-2}\nabla \cdot \vec{r} + \vec{r} \cdot \nabla r^{-2} \\ &= 3r^{-2} + \vec{r} \cdot (-2r^{-3}\vec{r}) \\ &= 3r^{-2} - 2r^{-4}\vec{r} \cdot \vec{r} \\ \nabla \cdot \left(\frac{\vec{r}}{r^2} \right) &= 3r^{-2} - 2r^{-4}r^2 = r^{-2} \end{aligned}$$

Now

$$\nabla^2 \left[\nabla \cdot \left(\frac{\vec{r}}{r^2} \right) \right] = \nabla^2(r^{-2})$$

Applying result (i) of Example 3 above with $a = 2$

$$= -2(-2 + 1)r^{-2-2} = 2r^{-4}.$$

EXERCISE

Laplacian ∇^2

- Show that $\nabla \cdot (\nabla f) = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2}$
- Calculate $\nabla^2 f$ when $f = 4x^2 + 9y^2 + z^2$

Ans. 28

- Find $\nabla^2 f$ at the point $(2, 3, 1)$ when $f = 10z$

Ans. $2xy^2z^2$; 12

- If $\vec{F} = r^2\vec{F}$ prove that

$$\nabla^2 \vec{F} = a(a + 3)r^{a-2}\vec{F}$$

- Show that ∇f is both solenoidal and irrotational if $\nabla^2 f = 0$.

15.7 CURVILINEAR COORDINATES: CYLINDRICAL AND SPHERICAL COORDINATES

It is more convenient in many problems to define the position of a point P in space by the

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SAP C_TS452_2022 Exam Syllabus Topics:

Topic	Details
Topic 1	<ul style="list-style-type: none"> Consumption-Based Planning: The primary focus of this topic is on describing and setting up MRP. It covers performing a planning run using different options.
Topic 2	<ul style="list-style-type: none"> Configuration of Purchasing: This topic explains settings in purchasing. It focuses on document types, account assignment categories, output processing and release procedures.
Topic 3	<ul style="list-style-type: none"> Sources of Supply: This topic covers elements of price determination, purchasing info records, central contracts, scheduling agreements, and price changes.

Topic 4	<ul style="list-style-type: none"> Invoice Verification: It explains invoice verification, variances and blocks, subsequent debits credits, delivery costs, credit memos and reversals, and GR IR account maintenance functions.
Topic 5	<ul style="list-style-type: none"> Analytics in Sourcing and Procurement: It focuses on the application of embedded analytics capabilities to analyze procurement KPIs.
Topic 6	<ul style="list-style-type: none"> Inventory Management and Physical Inventory: This topic covers goods receipts, goods issues, transfers, and special processes related to the inventory management.
Topic 7	<ul style="list-style-type: none"> Purchasing Optimization: The topic delves into source lists, quota arrangements, priorities, sources of supply, catalogs, purchase requisitions, order confirmations and deliveries.
Topic 8	<ul style="list-style-type: none"> Procurement Processes: It covers basic and specific procurement processes, such as standard procurement, subcontracting, and self-service procurement.
Topic 9	<ul style="list-style-type: none"> SAP S 4HANA User Experience: It identifies key capabilities of SAP Fiori UX. Moreover, this topic explains the usage of SAP Fiori Launchpad for navigation.
Topic 10	<ul style="list-style-type: none"> Valuation and Account Assignment: It focuses on the assessment and configuration of account determination and material stock valuation.

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SAP Certified Application Associate - SAP S/4HANA Sourcing and Procurement Sample Questions (Q31-Q36):

NEW QUESTION # 31

You test the various options that SAP S/4HANA offers for stock transfers between two different plants within the same company code. Which of the following apply to stock transport orders? Note: There are 2 correct answers to this question.

- A. Two accounting documents are created at the time of goods issue posting - one for each plant.
- B. You can post the goods issue from inspection stock in the supplying plant.
- C. You can post the goods receipt to blocked stock in the receiving plant.
- D. The material on the road is managed as stock in transit in the receiving plant.

Answer: C,D

NEW QUESTION # 32

What are some key features of purchase-order-based invoice verification? Note: There are 2 correct answers to this question.

- A. The system proposes the quantity to be invoiced as the difference between the total delivered quantity and the total quantity already invoiced.
- B. The system proposes the total delivered quantity as the quantity to be invoiced.

- C. Partial deliveries for a purchase order item show up as individual items in the invoice document.
- D. Partial deliveries for a purchase order item are NOT flagged as individual invoice items.

Answer: A,C

NEW QUESTION # 33

For which of the following business scenarios does a situation template exist in Situation Handling? Note: There are 2 correct answers to this question.

- A. The due date for a blocked invoice has passed.
- B. A purchase order approval is pending.
- C. A contract is ready as a source of supply.
- D. A supplier confirmation is pending.

Answer: C,D

Explanation:

Explanation

Situation Handling is a feature that helps users deal with situations that require their attention or action. A situation template is a predefined configuration that defines the rules and actions for a specific type of situation. For the following business scenarios, a situation template exists in Situation Handling:

A supplier confirmation is pending, which means that a vendor has not confirmed a purchase order or has confirmed it with different conditions than expected.

A contract is ready as a source of supply, which means that a contract has been released and can be used as a valid source of supply for purchase requisitions or purchase orders. References: SAP S/4HANA Sourcing and Procurement | SAP Learning Course S4520, Unit 8, Lesson 1.

NEW QUESTION # 34

What must you do to implement split valuation?

Note: There are 2 correct answers to this Question

- A. Add valuation types to all open purchase order items.
- B. Create additional accounting data for the relevant materials.
- C. Customize valuation categories and valuation types.
- D. Assign valuation types to stock types.

Answer: B,C

Explanation:

Explanation

To implement split valuation, you must do the following:

Customize valuation categories and valuation types, which are the key elements of split valuation. A valuation category defines the criteria for splitting the valuation of a material, such as origin or quality.

A valuation type is a subdivision of a valuation category that represents a specific stock type, such as country of origin A or B. You can customize valuation categories and valuation types in Customizing under Materials Management -> Valuation and Account Assignment -> Split Valuation -> Configure Split Valuation.

Create additional accounting data for the relevant materials, which means that you must maintain the valuation data for each valuation type at valuation-area level. The valuation data includes the valuation price, total stock quantity, and total stock value for each valuation type. You can create additional accounting data for the relevant materials in the material master under Accounting 1 view. References: Split Valuation in Inventory Management | SAP Help Portal

NEW QUESTION # 35

Where can you set the parameter that allows changing the account assignment data for a consumable material during invoice receipt?

- A. In the account assignment category
- B. In the item category
- C. In the purchase order document type
- D. In the material master of the consumable material

Answer: A

Explanation:

Explanation

The account assignment category determines whether you can change the account assignment data for a consumable material during invoice receipt. You can set this parameter in Customizing for Materials Management under Purchasing -> Account Assignment -> Maintain Account Assignment Categories.

References: SAP S/4HANA Sourcing and Procurement | SAP Learning Course S4520, Unit 3, Lesson 2.

NEW QUESTION # 36

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