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Electrical Engineering: (Machine learning project)

# **PROBLEM STATEMENT NO.41 – POWER SYSTEM FAULT DETECTION AND CLASSIFICATION**

Presented By:

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ECE

# OUTLINE

- **Problem Statement** (Should not include solution)
- **Proposed System/Solution**
- **System Development Approach** (Technology Used)
- **Algorithm & Deployment**
- **Result (Output Image)**
- **Conclusion**
- **Future Scope**
- **References**

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# PROBLEM STATEMENT

- Design a machine learning model to detect and classify different types of faults in a power distribution system. Using electrical measurement data (e.g., voltage and current phasors), the model should be able to distinguish between normal operating conditions and various fault conditions (such as line-to-ground, line-to-line, or three-phase faults). The objective is to enable rapid and accurate fault identification, which is crucial for maintaining power grid stability and reliability.

# PROPOSED SOLUTION

- This project proposes a machine learning-based solution built using **IBM Cloud and Watsonx.ai** to automatically detect and classify electrical faults in a power distribution system.
- The approach involves collecting voltage and current phasor data under both normal and faulty operating conditions. Using **Watson Studio**, the data is preprocessed, and relevant features such as voltage magnitudes, current magnitudes, rate of change ( $dV/dt$ ,  $dI/dt$ ), and phase differences are extracted.
- A classification model is trained in **Watsonx.ai** to distinguish between different types of faults. Once trained, the model is deployed as a **RESTful API** using **Watson Machine Learning**, allowing real-time streaming data to be analyzed on the cloud.

# SYSTEM APPROACH

- **System Requirements:**
- Phasor data from sensors (real/simulated)
- Internet access for IBM Cloud
- Python environment for preprocessing
- **Process:**
- Upload and explore dataset
- Preprocess and label data
- Train ML model in Watsonx.ai
- Deploy as real-time API
- Evaluate and monitor performance

# ALGORITHM & DEPLOYMENT

- **Model Used:** Random Forest Classifier
- **Justification:** Works well with mixed data, interpretable, handles non-linearity.
- **Input Features:**
  - Voltage & current magnitudes ( $V_a$ ,  $V_b$ ,  $V_c$ ,  $I_a$ ,  $I_b$ ,  $I_c$ )
  - $dV/dt$ ,  $dI/dt$
  - Phase angle differences
- **Training Details:**
  - 80/20 data split
  - 5-fold cross-validation
  - Grid search for hyperparameter tuning
- **Deployment:**
  - Registered in Watson Machine Learning
  - Real-time prediction via REST API endpoint

# RESULT

The screenshot displays the IBM Watson AI Studio interface. The browser address bar shows the URL: `au-syd.dai.cloud.ibm.com/ml-runtime/deployments/ddef830c-6634-4369-9856-fb9b42c6d0a9/test?space_id=03d59870-...`. The page title is "Service Details - IBM Cloud". The main navigation bar includes "IBM watsonx.ai Studio", a search bar, and user information "Virendiran Raghupathy's A...". The breadcrumb trail indicates the current location: "Deployment spaces / project1 / P9 - Random Forest Classifier: veera1".

The "Prediction results" modal is open, showing the "Display format for prediction results" section with "Table view" selected. A "Show input data" toggle is also visible. The table displays the following data:

	prediction	probability
1	Transformer Failure	[0.3734864119504015,0.2282895044537885,0.3982240835958099]
2		
3		
4		
5		
6		
7		

A "Download JSON file" button is located at the bottom right of the modal. The Windows taskbar at the bottom shows the time as 00:27 on 05-08-2025, with a temperature of 28°C.

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# CONCLUSION

- The project proves that machine learning, when deployed with IBM Cloud and Watsonx.ai, can effectively classify faults in power distribution systems. The model provides high accuracy and fast response, enhancing reliability and helping reduce grid downtime.



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# FUTURE SCOPE

- Add fault **location prediction**
- Integrate with **real-time IoT sensors**
- Use **deep learning** (e.g., LSTM) for sequential time-series analysis
- Deploy to **edge devices** for low-latency fault detection
- Build a **fault dashboard** with real-time alerts and analytics

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