**STUDENT LAB SAFETY, HIRARC, DATASHEET VERIFICATION CHECKLIST, AND BRIEF REPORT SUBMISSION**

**EXPERIMENT CM8: ANALOG MODULATION USING MATLAB**

**STUDENT NAME : _____**
**MATRIC NO. : _____**
**GROUP : _____**
**DATE : _____**

**A. Software and Simulation Verification Checklist**

**Complete this checklist before recording the final simulation results.**

| Item | Verification Requirement | ✓ |
|---|---|---|
| MATLAB | MATLAB launched successfully | ☐ |
| Working Folder | Experiment folder created and correctly selected | ☐ |
| MATLAB Script | Supplied script loaded and examined | ☐ |
| Script Execution | Script runs without unresolved errors | ☐ |
| Message Signals | Four message signals generated correctly | ☐ |
| Carrier Signal | Carrier amplitude and frequency verified | ☐ |
| Sampling Frequency | Initial value set to 2 kHz | ☐ |
| AM | Conventional AM signals generated | ☐ |
| DSB-SC AM | DSB-SC signals generated | ☐ |
| PM | Phase-modulated signals generated | ☐ |
| FM | Frequency-modulated signals generated | ☐ |
| Modulation Constants | $k_a$, $k_p$, and $k_f$ verified | ☐ |
| Complete Simulation | All 16 modulation combinations completed | ☐ |
| Piecewise Signal | Specified piecewise signal implemented | ☐ |
| Sampling Comparison | Simulation repeated at 3 kHz | ☐ |
| Plot Presentation | Titles, axes, units, and legends included | ☐ |
| Results | Required plots and observations recorded | ☐ |
| File Management | MATLAB and report files saved and backed up | ☐ |

**Verification Outcome**

| Verification Status | ✓ |
|---|---|
| All requirements completed satisfactorily | ☐ |
| Minor corrections required | ☐ |
| Simulation approved to proceed | ☐ |

**B. HIRARC Checklist**

| Hazard or Unsafe Condition | Potential Consequence | Control Measure | ✓ |
|---|---|---|---|
| Damaged electrical equipment | Electric shock or equipment damage | Inspect the workstation and report any damage | ☐ |
| Food or drinks near computer | Short circuit or equipment damage | Keep food and drinks away from equipment | ☐ |
| Loose workstation cables | Tripping or accidental disconnection | Maintain a clear and organized workspace | ☐ |
| Poor workstation posture | Physical discomfort and fatigue | Adjust chair, screen, and sitting position | ☐ |

| | | | |
|---|---|---|---|
| **Prolonged screen exposure** | **Eye strain and reduced concentration** | **Take appropriate periodic breaks** | ☐ |
| **Incorrect MATLAB syntax** | **Simulation failure** | **Check error messages and correct the script** | ☐ |
| **Incorrect sampling frequency** | **Aliasing and invalid signal representation** | **Verify the sampling and Nyquist frequencies** | ☐ |
| **Incorrect time vector** | **Distorted or incomplete waveforms** | **Verify $T_s = 1/f_s$and simulation duration** | ☐ |
| **Incorrect modulation constants** | **Distortion or misleading results** | **Change constants systematically and record values** | ☐ |
| **Excessive $k_a$** | **AM overmodulation** | **Monitor the modulation index and envelope** | ☐ |
| **Excessive $k_f$** | **Spectral spreading or aliasing** | **Check frequency deviation and sampling limit** | ☐ |
| **Incorrect MATLAB operators** | **Invalid calculations or dimension errors** | **Use element-wise operators where required** | ☐ |
| **Incorrect result selection** | **Invalid analysis and conclusions** | **Verify parameters before saving each figure** | ☐ |
| **Failure to save files** | **Loss of simulation work** | **Save and back up files regularly** | ☐ |
| **Alteration of results** | **Breach of engineering ethics** | **Report actual MATLAB results only** | ☐ |
| **Copying another student's work** | **Academic misconduct** | **Submit independently generated work** | ☐ |

**Risk Level after Control Measures: ☐ Low ☐ Medium ☐ High**

**C. Engineering Practice Verification**
**Complete this section after obtaining the simulation results.**

| **Engineering Practice Requirement** | ✓ |
|---|---|
| **Governing equations for AM, DSB-SC AM, PM, and FM reviewed** | ☐ |
| **Four message signals identified correctly** | ☐ |
| **Mathematical expressions of the message signals determined** | ☐ |
| **Carrier amplitude and frequency verified** | ☐ |
| **Sampling theorem considered before simulation** | ☐ |
| **Message, carrier, and modulated signals have compatible dimensions** | ☐ |
| **Element-wise MATLAB operations used correctly** | ☐ |
| **Numerical integration for FM checked** | ☐ |
| **Four conventional AM results obtained** | ☐ |
| **Four DSB-SC AM results obtained** | ☐ |
| **Four PM results obtained** | ☐ |
| **Four FM results obtained** | ☐ |
| **All 16 modulation combinations completed** | ☐ |
| **Effects of $k_a$, $k_p$, and $k_f$evaluated** | ☐ |
| **AM overmodulation checked** | ☐ |
| **Piecewise message signal implemented and verified** | ☐ |
| **Simulations at 2 kHz and 3 kHz compared** | ☐ |
| **Time-domain results compared with theory** | ☐ |
| **Frequency-domain results interpreted correctly** | ☐ |
| **Carrier and sideband components identified where applicable** | ☐ |
| **All figures contain readable titles, axes, units, and legends** | ☐ |

| | |
|---|---|
| **Results supported by actual MATLAB outputs** | ☐ |
| **Unexpected results investigated and discussed** | ☐ |
| **MATLAB script and report files saved and backed up** | ☐ |
| **Engineering ethics and data integrity maintained** | ☐ |

**Engineering Practice Outcome**

| **Verification Statement** | ✓ |
|---|---|
| **Simulation procedure follows acceptable engineering practice** | ☐ |
| **Results have been checked against theoretical expectations** | ☐ |
| **Recorded results are supported by actual MATLAB outputs** | ☐ |
| **Experiment is ready for reporting and assessment** | ☐ |

**D. Student Declaration**

**I confirm that:**

**☐ The MATLAB script was examined before execution.**

**☐ The carrier amplitude, carrier frequency, sampling frequency, simulation duration, and modulation constants were verified.**

**☐ The four message signals were identified, generated, and analysed correctly.**

**☐ The mathematical expression and relevant characteristics of each message signal were determined.**

**☐ Conventional AM, DSB-SC AM, PM, and FM were generated for all four message signals.**

**☐ All 16 required message-signal and modulation combinations were completed.**

**☐ The MATLAB operations used to implement the four modulation techniques were examined and understood.**

**☐ The effects of varying $k_a$, $k_p$, and $k_f$ were investigated systematically.**

**☐ AM overmodulation, PM phase deviation, and FM frequency deviation were considered when interpreting the results.**

**☐ The specified piecewise message signal was implemented and modulated using all four modulation techniques.**

**☐ The experiment was completed using sampling frequencies of 2 kHz and 3 kHz.**

**☐ The sampling theorem and Nyquist-frequency requirements were considered.**

**☐ Time-domain and frequency-domain figures were obtained from actual MATLAB simulation results.**

**☐ All figures were labelled using appropriate titles, axes, units, legends, and parameter values.**

**☐ Recorded results and observations are accurate and have not been altered or fabricated.**

**☐ Unexpected results were investigated and reported honestly.**

**☐ The MATLAB script and report files were saved and backed up.**

**☐ The submitted simulation, results, figures, and explanations represent my own work.**

**☐ Engineering ethics, data integrity, and academic integrity were maintained throughout the experiment.**

**Student Signature : _____**

**Date : _____**

## E. Experimental Data, Results and Discussion

### E1. Simulation Parameters

| Parameter | Symbol | Initial Value | Unit |
|---|---|---|---|
| Sampling frequency | $f_s$ | 2,000 | Hz |
| Sampling period | $T_s = 1/f_s$ | | s |
| Simulation duration | $T$ | | s |
| Carrier amplitude | $A_c$ | | V |
| Carrier frequency | $f_c$ | | Hz |
| AM sensitivity constant | $k_a$ | | |
| PM sensitivity constant | $k_p$ | | rad/V |
| FM sensitivity constant | $k_f$ | | Hz/V |

### E2. Message-Signal Identification

| Signal | Waveform Type | Mathematical Expression | Amplitude | Frequency |
|---|---|---|---|---|
| $m_1(t)$ | | | | |
| $m_2(t)$ | | | | |
| $m_3(t)$ | | | | |
| $m_4(t)$ | | | | |

### E3. Analog-Modulation Results

**Complete the table using the actual MATLAB simulation results.**

| Message Signal | Modulation | Constant Used | Main Time-Domain Observation | Main Spectral Observation |
|---|---|---|---|---|
| $m_1(t)$ | AM | $k_a =$ | | |
| $m_1(t)$ | DSB-SC AM | $k_a =$ | | |
| $m_1(t)$ | PM | $k_p =$ | | |
| $m_1(t)$ | FM | $k_f =$ | | |
| $m_2(t)$ | AM | $k_a =$ | | |
| $m_2(t)$ | DSB-SC AM | $k_a =$ | | |
| $m_2(t)$ | PM | $k_p =$ | | |
| $m_2(t)$ | FM | $k_f =$ | | |
| $m_3(t)$ | AM | $k_a =$ | | |
| $m_3(t)$ | DSB-SC AM | $k_a =$ | | |
| $m_3(t)$ | PM | $k_p =$ | | |
| $m_3(t)$ | FM | $k_f =$ | | |
| $m_4(t)$ | AM | $k_a =$ | | |
| $m_4(t)$ | DSB-SC AM | $k_a =$ | | |
| $m_4(t)$ | PM | $k_p =$ | | |
| $m_4(t)$ | FM | $k_f =$ | | |

### E4. Effect of Modulation Constants

| Constant | Values Tested | Main Effect Observed | Selected Value |
|---|---|---|---|
| $k_a$ | | Change in AM envelope and modulation index | |
| $k_p$ | | Change in phase deviation | |
| $k_f$ | | Change in instantaneous-frequency deviation | |

**E5. Piecewise Message-Signal Results**
**The piecewise message signal is:**

$$m_5(t) = \begin{cases} t, & 0 \le t < 1, \\ -t + 2, & 1 \le t \le 2, \\ 0, & \text{otherwise}. \end{cases}$$

| Modulation | Constant Used | Main Observation |
|---|---|---|
| AM | $k_a =$ | |
| DSB-SC AM | $k_a =$ | |
| PM | $k_p =$ | |
| FM | $k_f =$ | |

**E6. Sampling-Frequency Comparison**

| Comparison Item | $f_s = 2$kHz | $f_s = 3$kHz | Observation |
|---|---|---|---|
| Sampling period | | | |
| Nyquist frequency | | | |
| Number of samples | | | |
| Time-domain appearance | | | |
| Frequency-domain representation | | | |
| Computational requirement | | | |

**DISCUSSION:**

**CONCLUSION:**

**LAB LECTURER**
**SIGNATURE : _____**

**DATE : _____**

**INSTRUCTOR**
**SIGNATURE : _____**

**DATE : _____**