Table 1. New results on ZINC and ZINC-Full Datasets. Baselines results are directly from their original papers. We improves our ENGNN performance by training more epoches (1000) following previous work. Our model ENGNNo outperforms all baselines include subgraph GNNs GNN-AK+,ESAN, SUN, SSWL, DRFWL, CIN, and NGNN

	zinc MAE↓	zinc-full MAE↓
GIN	$0.163_{\pm 0.004}$	$0.088_{\pm 0.002}$
GNN-AK+	$0.080_{\pm 0.001}$	–
ESAN	$0.102_{\pm 0.003}$	$0.029_{\pm 0.003}$
SUN	$0.083_{\pm 0.003}$	$0.024_{\pm 0.003}$
SSWL	$0.083_{\pm 0.003}$	$0.022_{\pm 0.002}$
DRFWL	$0.077_{\pm 0.002}$	$0.025_{\pm 0.003}$
CIN	$0.079_{\pm 0.006}$	$0.022_{\pm 0.002}$
NGNN	$0.111_{\pm 0.003}$	$0.029_{\pm 0.001}$
ENGNN	$0.068_{\pm 0.003}$	$0.021_{\pm 0.003}$

Table 2. Ablation study on ZINC-Full datasets. C=1, C=16, C=64 meaning that we use the tuned hyperparameters except setting number of noise channels to 1, 16, 64. layer=2, layer=3 means using mlp layer in deepset to 2(default) and 3 for ablation.

model	C=1	C=16	C=64	layer=2	layer=3
MAE	$0.027_{\pm 0.004}$	$0.021_{\pm 0.003}$	$0.024_{\pm 0.003}$	$0.021_{\pm 0.003}$	$0.025_{\pm 0.003}$

Table 3. Apply Equivariant Layer to GPS Graph Transformer on ZINC dataset. By replacing the message passing layer in GPS with our equivariant noise layer and use the original hyperparameters, we achieve good performance on ZINC.

model	GPS	GPS-ENGNN
MAE	$0.070_{\pm 0.003}$	$0.071_{\pm 0.004}$

Table 4. Comparison between ENGNN and GNN-RNI (Abboud et.al.) on EXP dataset. Baseline results are directly from GNN-RNI origin paper. We keep the same hidden dimension and training epochs.

Model	GCN-RNI	PPGN	1-2-3-GCN-L	3-GCN	ENGNN
Acc (%)	$98.0_{\pm 1.85}$	50.0	50.0	$99.7_{\pm 0.00}$	$100.0_{\pm 0.00}$

Table 5. Comparison between ENGNN and rGIN (Sato et.al.) on rGIN's dataset. Baseline results are directly from the origin paper. We keep the same hidden dimension and training epochs. Results are all in roc-auc score ↑.

dataset	TRI(N)	TRI(X)	LCC(N)	LCC(X)	MDS(N)	MDS(X)	MUTAG	NCI1	PROTEINS
GINs	0.500	0.500	0.500	0.500	0.500	0.500	$0.946_{\pm 0.034}$	$0.870_{\pm 0.009}$	$0.806_{\pm 0.029}$
rGINs	0.908	0.926	0.811	0.852	0.807	0.810	$0.949_{\pm 0.040}$	$0.876_{\pm 0.010}$	$0.810_{\pm 0.020}$
ENMPNN	1.000	1.000	1.000	1.000	$0.936_{\pm 0.030}$	$0.934_{\pm 0.04}$	$0.956_{\pm 0.054}$	$0.922_{\pm 0.022}$	$0.814_{\pm 0.023}$

Table 6. Results on node classification datasets: Mean accuracy (%) ± standard variation.

DATASETS	GIN	GAT	GCN	APPNP	CHEBYNET	GPRGNN	BERNNET	ENGNN	MPNN	NMPNN
CORA	$86.58_{\pm 0.97}$	$88.03_{\pm 0.79}$	$87.14_{\pm 1.01}$	$88.14_{\pm 0.73}$	$86.67_{\pm 0.82}$	$88.57_{\pm 0.69}$	$88.52_{\pm 0.95}$	$\mathbf{88.85_{\pm 0.96}}$	$87.36_{\pm 0.52}$	$20.11_{\pm 2.01}$
CITESEER	$77.11_{\pm 0.76}$	$80.52_{\pm 0.71}$	$79.86_{\pm 0.67}$	$\mathbf{80.47_{\pm 0.74}}$	$79.11_{\pm 0.75}$	$80.12_{\pm 0.83}$	$80.09_{\pm 0.79}$	$79.97_{\pm 0.79}$	$79.62_{\pm 0.75}$	$20.80_{\pm 2.63}$
PUBMED	$86.93_{\pm 0.26}$	$87.04_{\pm 0.24}$	$86.74_{\pm 0.27}$	$88.12_{\pm 0.31}$	$87.95_{\pm 0.28}$	$88.46_{\pm 0.33}$	$88.48_{\pm 0.41}$	$\mathbf{89.79_{\pm 0.64}}$	$89.53_{\pm 0.29}$	$69.28_{\pm 3.14}$
COMPUTERS	$58.87_{\pm 7.55}$	$83.23_{\pm 0.39}$	$83.32_{\pm 0.33}$	$85.32_{\pm 0.37}$	$87.54_{\pm 0.43}$	$86.85_{\pm 0.25}$	$87.64_{\pm 0.44}$	$\mathbf{90.48_{\pm 0.31}}$	$89.53_{\pm 0.83}$	$66.42_{\pm 1.39}$
PHOTO	$87.13_{\pm 4.52}$	$90.94_{\pm 0.68}$	$88.26_{\pm 0.73}$	$88.51_{\pm 0.31}$	$93.77_{\pm 0.32}$	$93.85_{\pm 0.28}$	$93.63_{\pm 0.35}$	$\mathbf{95.24_{\pm 0.58}}$	$94.74_{\pm 0.25}$	$65.12_{\pm 1.95}$
CHAMELEON	$66.87_{\pm 2.72}$	$63.13_{\pm 1.93}$	$59.61_{\pm 2.21}$	$51.84_{\pm 1.82}$	$59.28_{\pm 1.25}$	$67.28_{\pm 1.09}$	$68.29_{\pm 1.58}$	$\mathbf{71.40_{\pm 1.29}}$	$67.18_{\pm 1.07}$	$41.25_{\pm 1.38}$
ACTOR	$36.66_{\pm 7.53}$	$33.93_{\pm 2.47}$	$33.23_{\pm 1.16}$	$39.66_{\pm 0.55}$	$37.61_{\pm 0.89}$	$39.92_{\pm 0.67}$	$\mathbf{41.79_{\pm 1.01}}$	$40.64_{\pm 0.67}$	$40.41_{\pm 1.53}$	$23.73_{\pm 2.36}$
SQUIRREL	$40.53_{\pm 1.16}$	$44.49_{\pm 0.88}$	$46.78_{\pm 0.87}$	$34.71_{\pm 0.57}$	$40.55_{\pm 0.42}$	$50.15_{\pm 1.92}$	$51.35_{\pm 0.73}$	$\mathbf{52.77_{\pm 1.43}}$	$51.99_{\pm 1.78}$	$38.25_{\pm 1.04}$